THE MODEL ENGINEER

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THE MODEL ENGINEER

EVERY THURSDAY

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Our Cover Picture

Many of our older readers, who have had to learn engineering practice in the hard way, will envy modern students for the excellent facilities which they now find available in many technical schools and training establishments for basic instruction in skilled crafts, using both hand and machine tools. Our photograph shows a 16-year old student at the Braintree Technical and Arts Institute, operating an 18-in. Alba shaping machine, the operation in progress being the slotting of a toolholder rest on the body casting of a twin-head tool grinder. Mr. D. H. Downie, who took the photograph, designed this machine as an exercise for the students, and the castings were made from his own patterns ; his evening classes have already made five of these grinders for use in their own workshops. The set-back toolholder seen on the shaper, which takes ⅜ in. square tools, was made by first year students of 15 to 16 years of age. We are informed that the student in the photograph is a keen model engineer and a regular "M.E." reader; he is leaving shortly to take up an engineering apprenticeship.

SMOKE RINGS

Federation in Cardiff

WE LEARN that the Cardiff and District Federation of Model Clubs and Societies has recently been formed. Its objects are to promote, develop and encourage modelling and inter-club activity, and, whilst assisting affiliated clubs wherever possible, it will in no way interfere with the domestic affairs of any club and shall have no control over its assets. As the title implies, the area covered by the new federation is Cardiff and district, and any model club or society in the area may apply for affiliation.

In these days, when the number of model clubs and societies is steadily growing, federations are likely to become more and more desirable and even necessary, especially in areas where there may be several clubs or societies functioning within a radius of up to twenty miles. Together, under one head, the clubs in any district can achieve much, whereas singly, they may be faced with difficulties which sometimes amount to frustration.

We trust that the efforts of the Cardiff Federation will meet with the hoped-for success. The hon. secretary is Mr. R. S. Page, 11, Twyn-y-fedwen Road, Gabalfa, Cardiff.

A Heavy Present

THE NATIONAL Model Railroad Association, British Region, has been given a locomotive bell by the Canadian Pacific Railway. The bell, weighing nearly 250 lb. and suitably inscribed, was formally handed over by a C.P.R. official at the association's annual convention banquet at the Charing Cross Hotel, London.

The bell is to be kept in the Railway Museum at York, where there is already another C.P.R. locomotive bell to keep it company; the engine *Royal Scot* came back with one from its pre-war tour of Canada and the United States where it hauled the "Royal Scot" train. When the engine was re-designed a few years ago, the bell had to go . . . it went to the Railway Museum.

The headquarters of the National Model Railroad Association is in the United States; the British Region is the only one outside the U.S.A. The association was founded before the war and its original function was to specify scales and gauges to be used as standard by modelmakers.

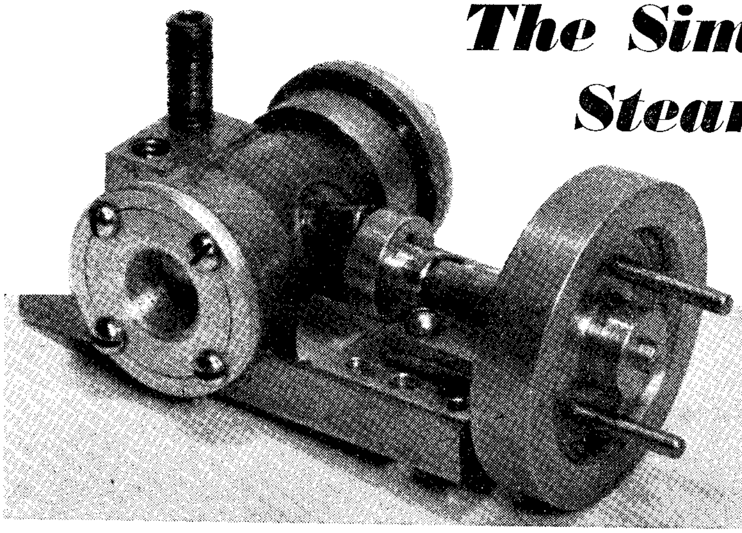
Calling Worcester

WHAT HAS happened to the interest in our hobby in the fine old county town of Worcester ? We have recently heard a sorry story that seems to indicate a decline in the model making activities which once were so prominent there. Not so many months ago, we reported the enterprise of the Worcester Model Engineering Society in arranging a display of its members' work in connection with the showing of a popular film at a local cinema; yet Mr. F. L. Fudger, the hon. secretary reports that the membership tends to decline rather than increase.

This is the time of year when most societies are preparing their annual general meetings and planning their future programmes, and therefore look to every member to pull his weight and lend every possible support. We trust that every past and present member of the Worcester M.E.S. and, for that matter, every other model engineering society, will rally round and go to the rescue of the hard-working executives.

To mention only one amenity in the Worcester society, an outdoor track for 3½ in. and 5 in. gauges is in course of construction. The society's workshop contains useful machinery and equipment, including a new welding set. It seems surprising that, in spite of such facilities, membership should be declining.

With a view to investigating and discussing the situation, an extra-ordinary general meeting is to be held on Thursday, December 3rd, at 7.30 p.m., at the Labour Club, New Street, Worcester. Anyone interested is invited to attend, and air his views. Alternatively, he should get in touch with Mr. Fudger, whose address is 23, Camp Hill Road, Battenhall, Worcester.



The Simplest Steam Engine?

By C. Horace Clarke

THE oscillating cylinder maintains its popularity for small steam engines where the purpose is merely to drive something rather than the appearance of the engine. Nevertheless it has its drawbacks; the friction of the sliding faces, the spring to keep them in contact, and only one impulse per revolution, requiring a larger flywheel. Two cylinders are difficult to arrange (except horizontally, acting on one crank, making an engine usually too wide for a small boat), whilst a double-acting cylinder is as difficult to make as a slide-valve cylinder. The steam ways have to be brought endways from near the centre, and piston-rod and stuffing-box must be provided. Crosshead slides carried by the cylinder cover must also be used if the piston-rod is not to exert sideways pressure on the gland to effect the oscillation.

It was with a view to providing an engine which would do the same work as one with a double-acting oscillating cylinder and at the same time be much simpler, that the present design was evolved. It is suitable for small boats up to 30 in. long. Its steam distribution is not good, but it is no worse than that of the oscillating cylinder; in fact, it is exactly the same. That is, steam is on for the full length of the stroke, or if an early cut-off is arranged, there is a corresponding late admission. This, however, is not a serious disadvantage in small models, as the empty space to be filled with steam when the inlet port opens is negligible. Pressure on the piston can do nothing until the crank is appreciably off the dead centre, and this engine works at its best with the admission occurring between one-eighth and one-quarter stroke, giving two detached impulses per revolution.

The engine has one double-acting cyclinder, fixed across the shaft axis, a low centre of gravity (at or below the shaft axis); no glands, no piston rod, no slides, and one shaft bearing. It has *only two moving parts*. Anyone who can turn a piston to fit a tube can make it, and the small amount of milling involved can be done on any lathe with a cross-slide on which work can be clamped.

The model shown in the photographs, including the flywheel, is entirely built up from left-over pieces; the bore of the cylinder is $\frac{1}{2}$-in., and the stroke of piston $\frac{1}{4}$ in. The cylinder is of solid drawn brass tube, and it should be at least 16 s.w.g. to avoid distortion at any stage, especially when lapping. The piston itself is made to act as a semi-rotary valve, this motion being imparted to it, during its reciprocating motion to drive the crank, by means of its direct connection to the crank-pin. By this motion, longitudinal grooves in the piston are brought alternately opposite inlet and exhaust ports in the cylinder wall. It does not matter which is the inlet and which the exhaust; they are interchangeable, and by changing over steam and exhaust ports by a 4-way cock or valve, the engine is reversible in exactly the same way as an oscillating cylinder.

Fig. 1 of the drawings is a longitudinal section of the engine but a cross section of the cylinder, these accepted nomenclatures becoming a bit involved when a machine has two major axes at right-angles. Fig 2 is a plan with the cylinder and piston in section. Both these views show the piston at one end of its stroke. The cylinder and piston are long in proportion to the stroke, the length of the piston being four times the stroke. A radial arm *a* is screwed into the centre of the piston and is bored at its outer end to fit a spherically-ended crankpin. The side of the cylinder has a circular opening *b* to clear this arm. This opening is much wider circumferentially than is necessary, but the size is required to permit the movement of the arm in the longitudinal direction and the circular hole is easiest bored. Those who prefer to file the hole can make it elliptical, which is the motion of the arm at the centre of its length when the outer end moves in the circular path of the crankpin. The piston is of hard aluminium alloy, and is probably light enough to be used solid. However, the ends are deeply recessed to reduce the weight of the comparatively large reciprocating mass, and the cylinder covers are correspondingly shaped and bored. All this is clearly shown in Fig. 2. The radial arm is of steel, and can be bored throughout its length if it is desired to reduce weight still further. An elevation of the piston showing the two longitudinal grooves is given in Fig. 3, which also shows how the grooves, at opposite ends, are connected to short drilled holes which communicate with the cylinder spaces at each end of the piston. If the thickness of the cylindrical ends of the piston permits, or where the piston is solid, the grooves may be run out to opposite ends and the drilling avoided. In the present engine, it was only conditions in the setting-up for milling these grooves that necessitated their being of the same length.

The circular opening in the cylinder enables the ports to be marked out to the exact dimensions on the inside of the cylinder, and then drilled

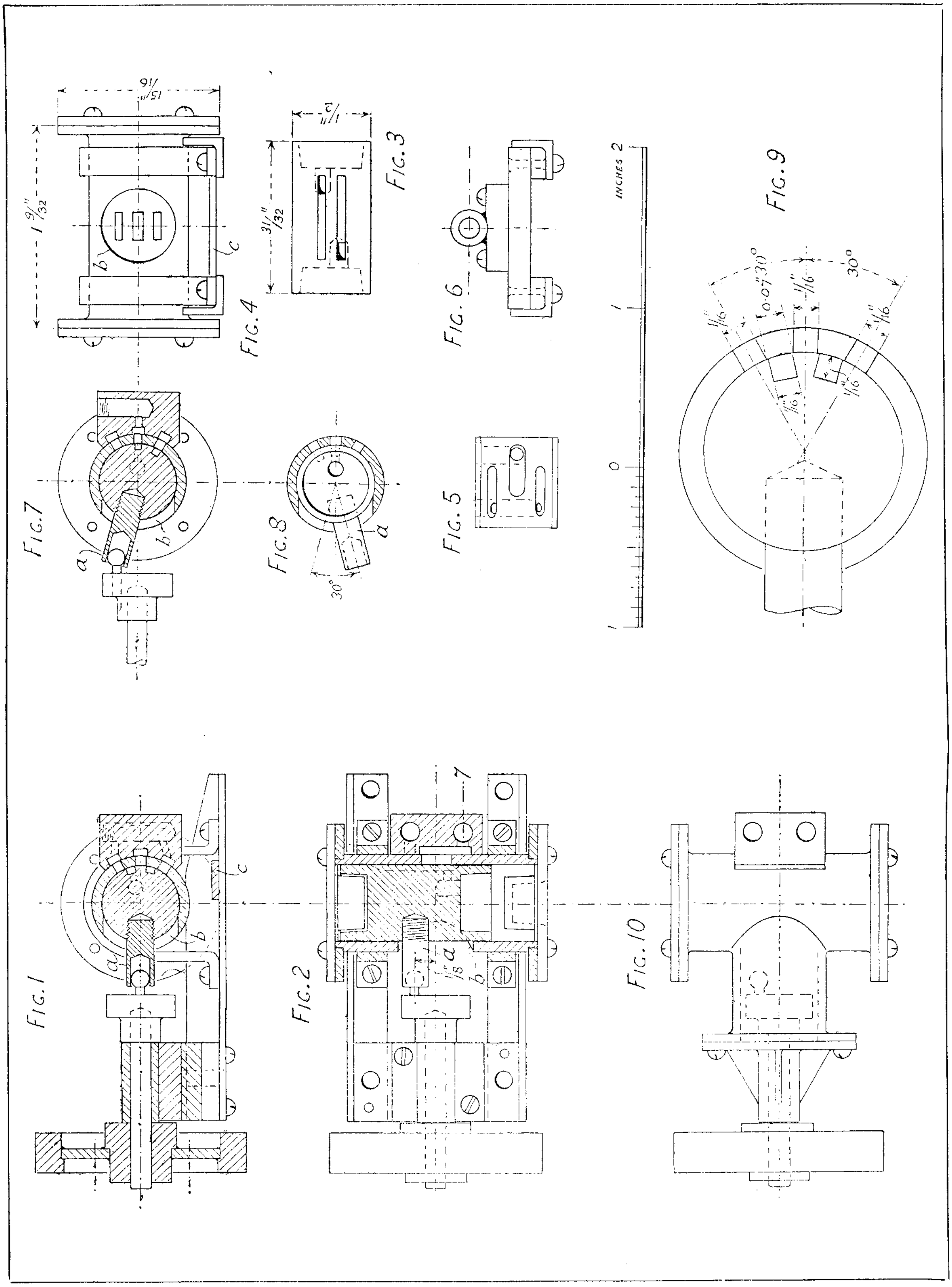


FIG. 1
FIG. 2
FIG. 3
FIG. 4
FIG. 5
FIG. 6
FIG. 7
FIG. 8
FIG. 9
FIG. 10
INCHES
30°
1/16"

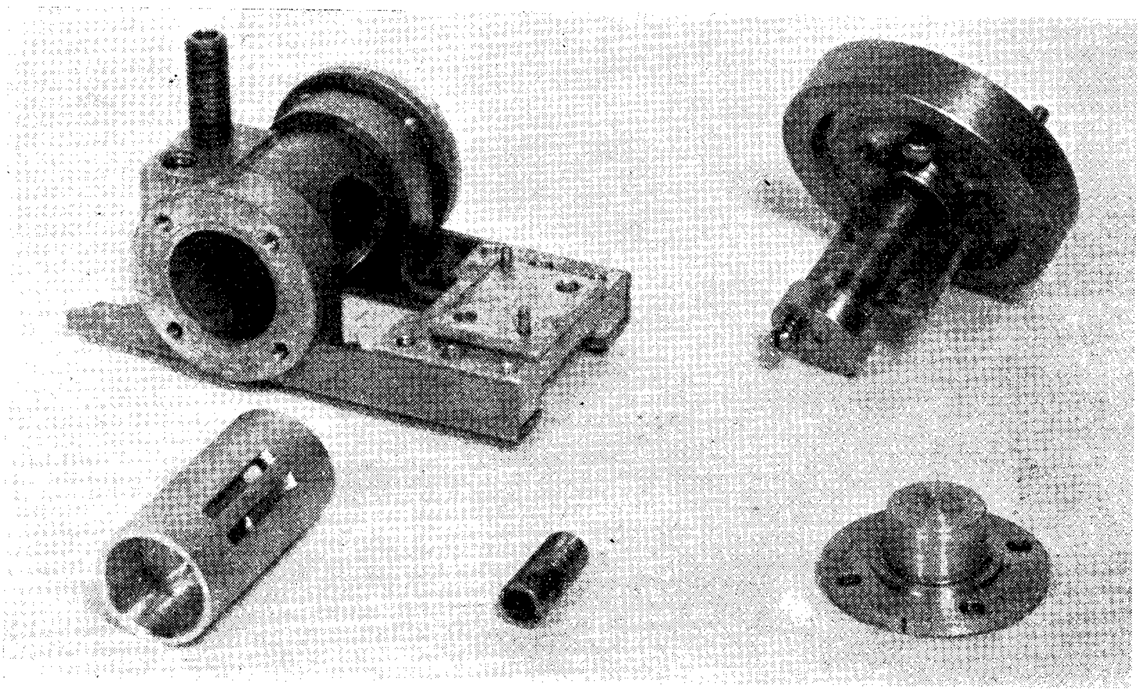
from the inside preparatory to filing to shape. There are three of these ports, as clearly seen in Fig. 4, which is an elevation of the cylinder as seen along the shaft axis. The centre port is connected to steam, and the outer two to exhaust, or *vice versa*. To make these connections, passages are formed in a block fixed to the side of the tube forming the cylinder, the steam and exhaust pipes being joined to the two vertical holes shown. A very good fit between this block and the cylinder must be made, or there will be difficulty in securing a steam-tight joint between all the passages, when it is soldered in place, without blocking up the passages. It is best to mill the face of the block with a cutter of the same diameter as the outside of the cylinder tube. When this is done, the block should be placed on the cylinder and the position of the ports scribed from the inside. Then three grooves are milled in the face, and if these are made slightly wider than the ports there will be less tendency for the solder to run into them or the ports. As shown in Fig. 5, which is a view of the concave face of the block, the groove from the centre port is carried towards one end of the block and those from the outer ports towards the other end; these grooves are then connected by drilling as shown, the former to one pipe connection, both the latter to the other. Faces of cylinder and block are then well tinned and wiped quite free of loose solder, and the two wired together. A very little solder placed on the outside should then secure a good joint without any excess to fill the passages. Test for leakage between passages by pressing a piece of adhesive tape firmly over the ports and applying air to one of the pipe connections with a bicycle pump whilst the whole is held under water. That tape is important; if one relies on, say, the piston to cover the ports, there will be leakage indicated between them which gets round this way. Finally, to make quite sure that the block does not shift if solder weakens at steam temperature, two Morse 60 holes are drilled into it at convenient points from inside the cylinder, tapped 12 B.A., and tightly plugged with brass screws, cut off and filed flush.

If the engine is not required to be reversible and a free exhaust direct to atmosphere is not objected to, this block can be dispensed with and a steam pipe connected direct to the centre port. Such an engine can be set to run in either direction by changing over the connections of the grooves to piston ends shown in Fig. 3.

After the end flanges have been soldered to the shouldered ends of the cylinder tube, the cylinder is well lapped. With a piston fitting to within 0.00025 in., neither rings nor packing should then be necessary in such a size.

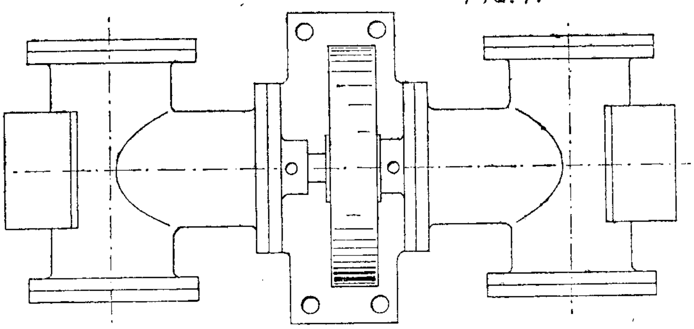
The single sleeve bearing for the crankshaft is a piece of brass tube soldered to a shallow groove filed across a brass plate; see Fig. 6 which is an end view of the framework. The support for this bearing, bridging the bedplate, is built up from aluminium. The " bedplate " is formed of two pieces of L-brass with a cross piece *c* soldered on. The latter is merely to keep them in correct association when the engine is taken apart; with the cylinder held in place it serves no purpose. The cylinder is clamped to shallow concave recesses in the upward flanges of the angles by means of two stirrups. Slight rotation of the cylinder is thus possible to align the ports should the crank-arm not be correctly centred opposite the piston grooves. Four holding-down holes are provided in the bedplate, two having to pass through the aluminium bearing support.

Threads used are: shaft to crank disc, $\frac{1}{8}$ in. Whit. (40 t.p.i.); crankpin



The component parts of the simple steam engine

FIG. 11



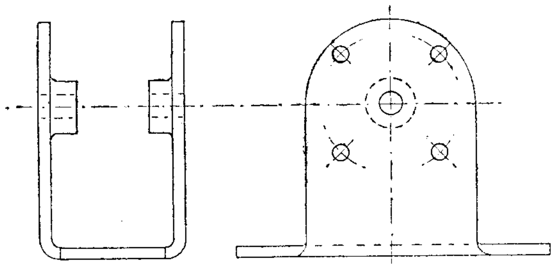


FIG. 11a

arm and pipe connections, $\frac{3}{16}$ in. 40 t.p.i. all the rest, 8 B.A. Round head screws have been used only because there was a quantity in stock.

The drawings show the engine arranged for clockwise rotation seen from flywheel end, steam to centre port. With the piston at the position shown in Figs. 1 and 2, the grooves lie opposite the spaces between ports in cylinder wall. If these grooves are slightly narrower than these spaces, the late admission and early cut-off previously mentioned will be provided for. (To give dead-centre admission, the grooves must be exactly the same width as the spaces between ports). In the said position, engine would not start anyway, crank being on dead centre. Rotation of crank will rotate piston clockwise, Fig. 1, to a starting postion, and at mid-stroke the position of piston shown in Fig. 7 will be reached, steam going from centre port via upper groove to far end of cylinder (top end in Fig. 2) whilst the other end is exhausting via lower groove and lower outer port. During the return stroke, the middle position of which is shown in Fig. 8, nearer end of cylinder (bottom end in Fig. 2) is receiving steam from centre port via lower groove, whilst far end is exhausting via upper groove and upper outer port. Figs. 7 and 8 are not strictly correct sections in the sense of being entirely on one plane. Fig. 7 is a section through cylinder and piston on centre line of shaft, but the section through the block is on a nearer plane, line 7 in Fig. 2. Fig. 8 is a section through cylinder on centre-line, but the piston is shown in end elevation and the block is omitted. Fig. 9 shows the dimensions for ports and grooves more clearly to a considerably enlarged scale, the piston being in central rotational position at end of stroke.

The engine described, and shown in the photographs, is as made experimentally with the parts evolved as they were required. The design is capable of improvement, and one idea in this direction is shown in Fig. 10. This is a plan of a totally enclosed engine with no framework other than the cylinder, crank case, and main bearing. A flanged branch is soldered to the cylinder over the crank-arm opening, and a similar flange carrying the bearing is fastened to it. This forms a very compact unit which can be fastened anywhere by means of the said flange. In the case of a boat, the flange can be fixed to a bulkhead or cross-plate by means of the screws which join the flanges; thus in place of eight assembly screws and four holding-down screws as in Fig. 2, there are four screws only. Oil put into the enclosed crank-case would provide splash lubrication for every part of this engine.

(*Continued on page* 643)

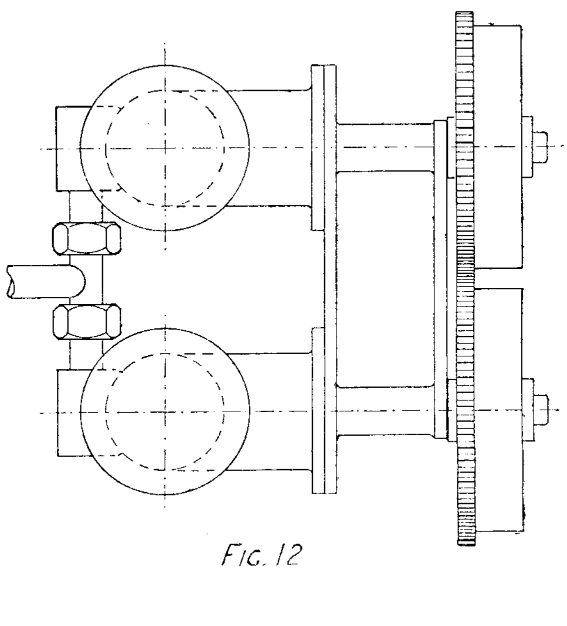


FIG. 12

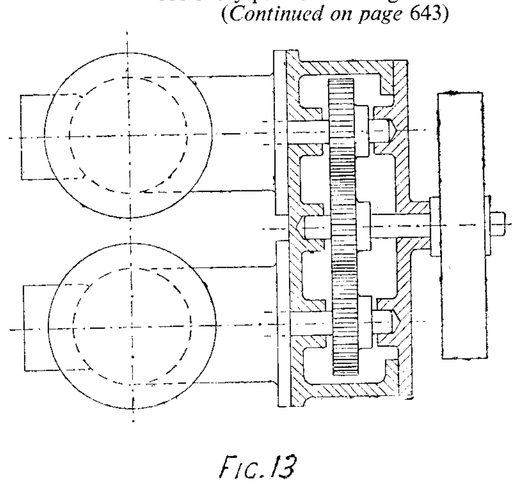


FIG. 13

More about HOT AIR ENGINES

By H. E. Rendall

MOST people, but by no means all, consider that the hot-air engine is dead and can never come back. Be that as it may, I feel that the hot-air engine holds a great interest for many people. Small engines have often enough been described in the pages of THE MODEL ENGINEER, so as a change, I give here, in Fig. 1, an illustration of a big 40 h.p. engine, constructed to drive a Dundee jute factory in the early part of the last century. This engine is not presented solely as a bold and well considered example of old-time engineering, that would make a showy model, but it is worth asking ourselves, whether suitably modernised, it could not compete with small petrol engines, especially in colonial countries. Its ability to use any fuel, solid or oil, is surely an enormous recommendation.

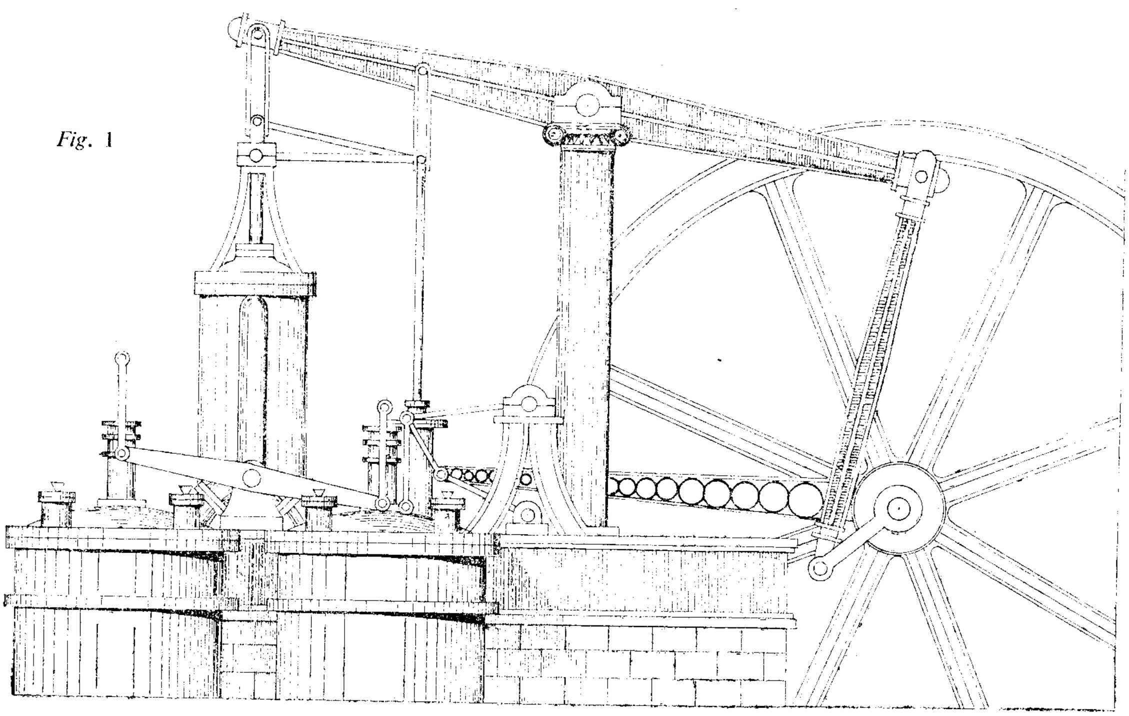
Regular readers will be familiar with the Stirling type of hot-air engine, invented by Dr. Robert Stirling about 1816, so no long description is necessary. Usually a light, hollow displacer moves the air in a cylinder to the hot end, where it expands and drives out a piston, or to the cool end, where it contracts and allows the piston to return. Some people claim that there is a double-acting effect, and that the slight vacuum pulls in the piston on the return stroke, but this is quite the wrong way to use a hot-air engine. The air is the medium, whereby the heat of the furnace is transformed to pressure on a piston and the more the medium in the form of compressed air that there is in the system, the more the power that can be extracted from the heat. This theory is more fully explained in an article by D. H. Chaddock in THE MODEL ENGINEER for January 23rd, 1941, so there is no need to say more than to mention that if the engine is charged with air at atmospheric pressure, the greatest pressure that could be developed with reasonable heating would be one atmosphere, i.e. 14.7 lb., but if the system were charged to 100 lb. per sq. in., a seven-fold increase in pressure might be expected. These facts were well known to Dr. Robert Stirling and Mr. James Stirling more than 120 years ago. Fig. 1 is copied to the best of my ability from a small woodcut in Elijah Galloway's book *The Steam Engine*, published in 1830, and later the same woodcut appears in the *Boy's Playbook of Science* (*circa* 1850). It shows clearly a beam engine with all the usual details of an early Victorian steam engine. The double-acting cylinder was 16 in. bore, by 4 ft. stroke. The size of the displacer cylinders is not given, but they were evidently of greater bore and shorter stroke.

Operating the Displacers

The eccentric strap and rod, of the old lattice form pattern, which would normally drive the slide-valve in a steam engine, are here used to rock a small subsidiary beam for operating the two displacers, one for each end of the cylinder. These, being in balance, would require little power to operate, as the engine only ran at 28 r.p.m.

The precise arrangement of links, whereby the eccentric-rod drove the displacer beam, is rather con-

Fig. 1



fused in the woodcut, and I have followed the woodcut in my drawing, but my own opinion is that the beam was lifted by a bellcrank, with its axis on the small elevated bearing, just to the left of the centre column. The small pump, driven from the parallel motion, like the air pump in a steam engine, was an air compressing pump for maintaining pressure in the system. It played no part in the cycle of operations, and was only put into operation at intervals, to make good any leakage past the glands or joints. Air was discharged by this pump into the hollow base, and thence through non-return valves into the cylinder connecting pipes, or "nosles," as Galloway picturesquely calls them.

Displacer Arrangements

I do not think that it is worth while giving Galloway's drawing of the displacer cylinder, but Fig. 2 is taken from Professor Rankine's book *The Steam Engine* (1866), and this probably shows the displacer arrangements in their most improved form. Galloway's drawing shows the displacer cylinder without any water-cooling arrangements at all, simply the bare top of the displacer cylinder was considered sufficient to dissipate the heat. The piston-rod had a very long guide, and in addition, there were four guide-rods to each displacer, with a small lubricator on top of the guides. Two of these are shown on each displacer cylinder in the drawing. *The Boy's Playbook*, states that the engine ran for three years and was discarded, because the "pots," as the bottoms of the displacer cylinders were called, were burnt out—an old trouble with hot-air engines. Rankine, on the other hand, states that the engine ran for several years. Who is right, I do not know, but it is probable that the pots did burn out and the opportunity was taken to put in an improved displacer cylinder. Referring to Fig. 2, *A* is the displacer plunger turned to be an easy, frictionless fit in the inner cylinder *B*. The displacer is filled with brickdust or some other heat insulator to keep the heat from rising to its upper surface. The hemi-spherical bottom of the inner cylinder is pierced with numerous holes, which were supposed to promote turbulence, and consequent quick transfer of heat to the air. In the annular space, between the outer cylinder *C* and the inner cylinder, oblong plates of metal or glass were hung as a "regenerator," or heat saver. As the hot blast of air rose to the top of the displacer cylinder, it heated these plates and they gave up the heat again when the cool air descended to be reheated. The cooler consists of a horizontal coil of fine copper tube, through which water is passed by a pump. No water cooling is applied to the displacer cylinder sides or cover. I expect Mr. Stirling feared that the cylinders might be cracked by uneven expansion if water was applied one end and fire to the other. Mr. Stirling gave the maximum temperature as 650 deg., minimum 150 deg. A very important claim for Stirling engines was that the air in the "nosles" and working cylinders acted as a cushion on which the hot-air acted, so that the working cylinders never got very hot, and Mr. Stirling was able to pack the piston-rods with a leather collar. This claim is quite justified, I am sure, as I used, when young, to haunt an engine shed in which there was a $\frac{7}{8}$ h.p. Stirling engine, and the working cylinder was never more than pleasantly warm to the hand.

Overheated cylinders and burnt lubricating oil were a terrible scourge

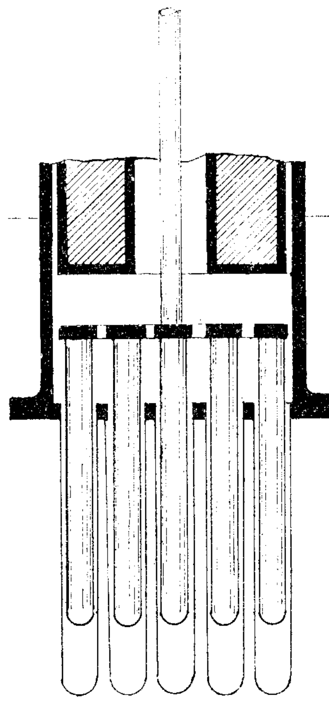


Fig. 3

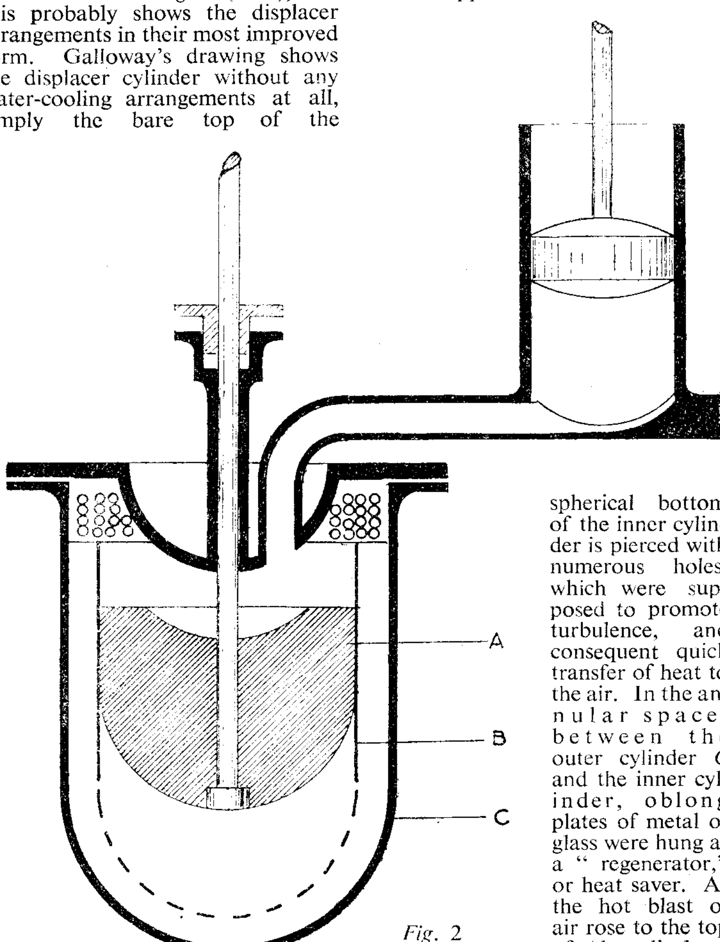


Fig. 2

to hot-air engines working on other cycles where heated air entered the cylinders direct, without a cool air cushion. Mr. Stirling published the results of his tests on this engine and stated that the mean pressure in the cylinder was 37.75 lb. per sq. in. at which pressure the engine developed 45 b.h.p. Was the dynamometer brake also used to stop and control the engine? I can see no sign of any governors or throttle-valve on the drawing, nor had the $\frac{7}{8}$ h.p. engine, that I have already referred to, any. It used to be one of the thrills of my young life to see the gardener trying to stop the engine by bearing heavily on the flywheel and grabbing a spoke at a tactful moment. This engine was decidedly more efficient than the giant 14 ft. bore hot-air engine in the ship *Ericsson*, and it must always be matter of regret that Captain Ericsson, who made literally thousands of hot-air engines, never tried using dense air. His hot-air engine gave the speed to the ship that was demanded by his financial backers i.e. six knots, when running at 9 r.p.m with a mean pressure of $2\frac{1}{2}$ lb. per sq. in., and ran more efficiently than almost any steam engine afloat, but we must get back to the Stirling engine.

Loss of Heat

There must have been a serious loss of heat by the hot air rising up to the working cylinder, being cooled by the watercooling coils in the upper part of the cylinder, and my experiments with a 2 in. bore Henrici engine confirm this view. I consider that a simple valve should be fitted to the power cylinder so that on the working stroke, air would be drawn from the hot end and on the return stroke discharged straight into the cold end. Further, I would remind readers that "Artificer" has suggested a rotary displacer in place of the more cumbersome reciprocating one. There is a good deal to be said for this suggestion. However, the reciprocating displacer can be improved, and I show in Fig. 3 a displacer invented by Professor Rankine and Mr. J. R. Napier. A plate carrying rods of metal is fitted below the normal displacer. The rods are heated, when fully plunged into the tubes, and there is a quick transfer of heat when the displacer is pulled up. The tubes also help to make the heating arrangements of the "pot" as efficient as a steam boiler —a very important point. At any rate, the hot air engine, using dense air, seems to offer a very fascinating field for experiment.

The "M.E." SPEED BOAT COMPETITION

REVISION OF RULES TO CONFORM WITH MODERN STANDARDS OF PERFORMANCE

It is now nearly half a century since the "M.E." first instituted an annual competition to encourage the development of model power boats, and during this time, the performance of fast model craft has improved out of all recognition, speeds having been multiplied nearly twenty times. As a result, it has been necessary to revise and amend the rules several times to cope with the advancing standards of performance, and also the prevailing tendencies in hull and engine design. The date of the last revision was in 1946, when the competition was resumed after the war years.

In the present revision, the general character of the competition has been maintained, and the differences introduced have been decided by the fact that speeds are still rapidly increasing, and also because it is very desirable that the rules should coincide closely with those of the Model Power Boat Association, whose experience in the organisation of speed events at regattas has been freely drawn upon. Three classes of boats, "A," "B" and "C," driven by either steam or i.c. engines, and conforming to M.P.B.A. classication, are eligible; the possibility of introducing a further class "D," which has been envisaged in view of the development of very small engines, has not been exploited, as very few boats conforming to this class have achieved notable success.

The speeds which have been achieved in the three existing classes indicate that small-capacity engines do not necessarily handicap performance, if hull design and power-weight ratio are in proportion, and, therefore, no distinctions are now made in the minimum qualifying speeds in each class. All boats which attain a speed of 45 miles per hour or over, irrespective of class, will be awarded a certificate of performance. As before, separate awards are made for steam and i.c. engine propelled boats, consisting of silver and bronze medals for first and second prizes respectively, for either type, in each class. Boats propelled by jet motors, or any form of propulsion other than mechanical means (such as screw propellers), are not eligible.

It should be borne in mind that the primary object of the competition remains, as it always has been, the encouragement of amateur research in, and construction of, high-performance boats and engines, rather than the pursuit of speed, pure and simple. For this reason, all boats entered must have both hulls and engines constructed by the entrant, either from his own or any other (specified) design, but considerable latitude is allowed in respect of the use of finished accessories. The boat must have been built, though not necessarily run, in the British Isles, and it may be entered in the joint names of not more than two persons.

The new entry forms have been designed to enable as many relevant details of both engine and hull design as possible to be obtained, with a view to producing an annual report which will show prevailing tendencies in design, and give statistical information of value to anyone wishing to build model speed boats. We do not expect competitors to give away carefully guarded secrets, but everyone will agree that the dissemination of general technical information is essential to progress.

As the timing of high-speed events has become a highly skilled and specialised affair, it has been laid down that two qualified observers, approved by the M.P.B.A., must be appointed for this duty. We do not think competitors will object to this, as practically all model power boat clubs in the country are affiliated to this Association, and "lone hands" are not likely to find any difficulty in contacting one of these clubs in their vicinity. Runs made at M.P.B.A. regattas, and officially reported in THE MODEL ENGINEER, will be accepted without further evidence.

Entry forms for this year's competition, the expiry date of which is December 31st, can be obtained from THE MODEL ENGINEER offices on receipt of a stamped addressed envelope.

L.B.S.C.'s Lobby Chat

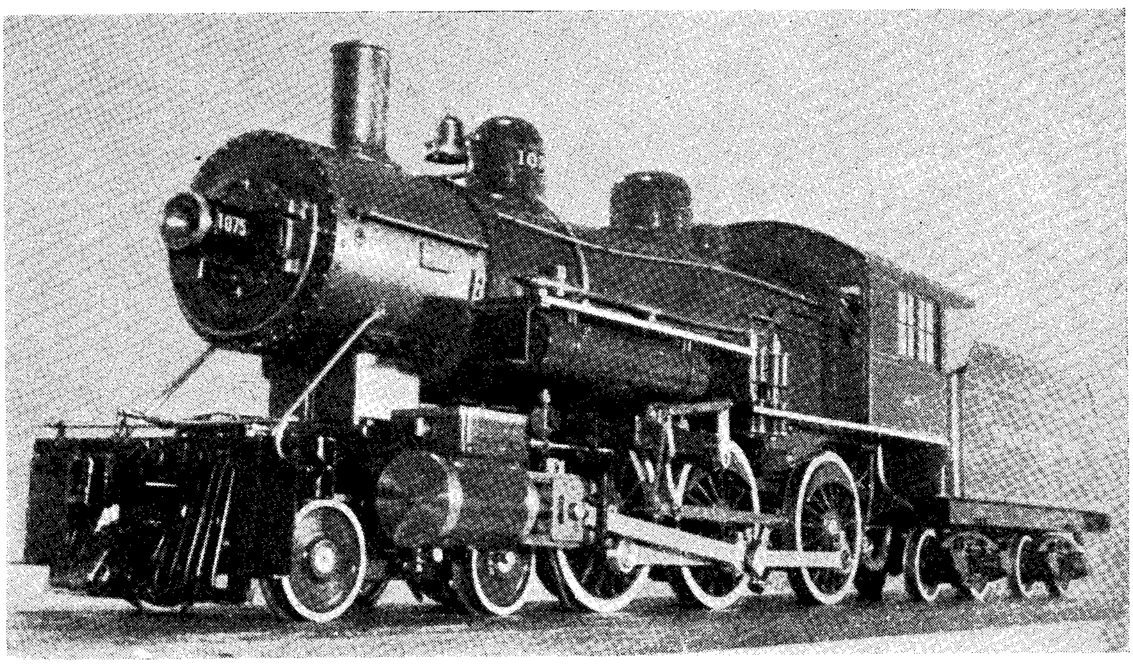
● EXHIBITION ABSENTEES

SINCE the closing of the recent "Model Engineer" Exhibition, I have received many letters, and have had several conversations about the reason why there were so few locomotives on show. It had been stated in preliminary notices that engines built to your humble servant's designs would be on view; and certain good folk who follow these notes, visiting the exhibition with the idea of seeing plenty, came away sadly disappointed. They seek to know the reason; well, I guess I can throw some light on the subject but before doing so, I would like to tell of a couple of incidents which actually happened around the turn of the century. They are both "gospel."

Early one Sunday afternoon, at one of the South London depots of the London Brighton & South Coast Railway, two old drivers who had been working an early turn signed the book and went into the lobby to pass the time of day with their fellow-conspirators, before departing to their respective homes and a late Sunday dinner. One of them remarked on a fault he had just booked on his engine, and said what he thought was the cause of it. The other said no, it wasn't that at all, and gave *his* version; but the first stuck to his guns, the second promptly retaliated, and a real "parliamentary debate" followed in the course of which the old boys called each other all the terms in the dictionary of railroad Esperanto, plus a few more of their own, to the great amusement of the other occupants of the lobby. Just at the point when the first driver was apparently on the point of having an apoplectic fit, he happened to glance at the clock, and exclaimed: "Blimey, Bill, look at the time! Damn the ruddy argument, come along, mate, or we'll be too —— late for a quick one before the pub shuts!" Hastily grabbing coats, tommy-bags, and tea-bottles, they dashed off, and in less than 90 secs were in the saloon bar of the Railway Tavern, just outside the depot toasting each other in a glass of good honest "barley wine" before wending their ways homeward. In the good old days, a difference of opinion never affected a friendship, unless to strengthen it; a pal who wasn't afraid to stick to his way of thinking, was a pal worth having. Now in the following observations, I'm going to have a difference of opinion with two or three very good friends, and I want them to understand that it is in *exactly the same spirit as those two old drivers*, to whose generation I belong. Nuff sed!

A Rush Job

Anecdote No. 2 concerns a job that was done in a mighty hurry, to keep an engine in service. As most older readers know, the L.B. & S.C.R. was pre-eminently a passenger line. It was the pioneer



Wouldn't Billy Van Brocklin's fine job create a sensation on the 5 p.m. from Cannon Street!

of day trips and cheap excursions; and during the summer months, in the height of the holiday season, it was the dickens' own job to find engines to work all the trains. Engines ran almost around the clock; it was no uncommon thing for goods engines which had been on their legitimate job all night, to get a hasty wipe down, as soon as they came in, and be sent off in the morning with a passenger excursion to the South Coast. Race meetings "piled on the agony"; while suburban tanks managed such jobs as the Epsom specials, anything that could pull a train was commandeered for Lingfield, Plumpton Lewes, Singleton (for Goodwood) and so on.

When the first lot of Billinton 4-4-0's (nicknamed the Grasshoppers) came out, the wheels had very spidery spokes, and some cracking developed; and it so happened, at the busiest time when the engine could least be spared, one of this class (to the best of my recollection, it was 203 *Henry Fletcher*) developed cracks in the spokes of both the driving-wheels. She was hastily packed off to Brighton Works for repair, as there were no suitable spares at the local depot. When she arrived and was examined—they did the job properly in those days—it was found that in addition to the cracked spokes, there was a soft spot on a bogie wheel, which had worn flat, and one of the tender journals was badly scored, the result of a bad case of "hot box." The bogie was dropped, wheels removed, and all four re-turned. A set of coupled wheels, intended for another engine of the same class, in for heavy repairs, was hastily requisitioned, to save time; these also had returned tyres. Also to save time, a complete new set of tender wheels, kept in store against emergency, were fitted, and the engine thus made good for service again, almost in a matter of hours. The lads of the old "Brighton" knew how to get a move on, when circumstances called for it! The engine was taken for a test run with a load of empties, up the Uckfield line, to make sure that there would be no hot boxes, and no "seesawing" caused by having another engine's coupled wheels; and all proving O.K.—or at least as near O.K. as could be got with this class of engine; they were nothing to write home about!—she was sent home right away, and was soon hauling trippers.

Now note: The tyres of her bogie wheels were thin, having been turned almost to the safety limit; the tyres of the coupled wheels were of medium thickness, having been re-turned after being taken off another engine; and the tender-wheel tyres, being brand new, were of full thickness.

Why the Criticism?

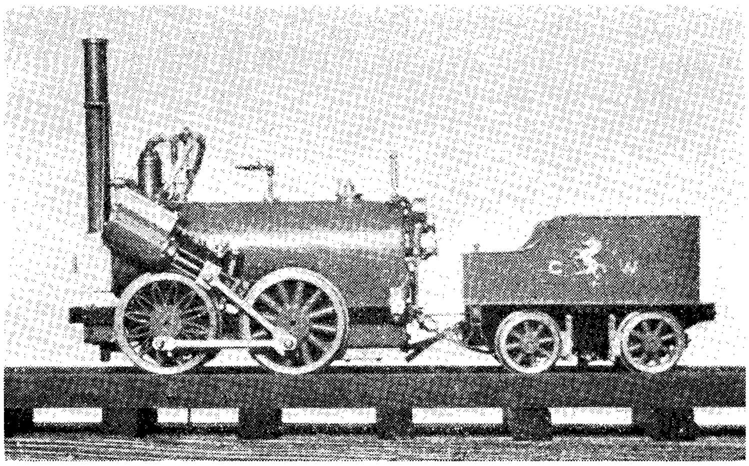
There was a 5-in. gauge Southern Railway L1 class locomotive shown at the Exhibition, built by Mr. R. K. Broadman, obviously from the drawings and instructions given in these notes for *Maid of Kent*. The wheel tyres of this engine were machined *precisely as mentioned above*, viz.: thin bogie, medium driving and coupled, and thick tender; but Messrs. Maskelyne and Dunn both found fault with them. The point that made me really chuckle, was that Mr. Dunn later mentioned, with evident relish, that he had seen rust marks *painted* on the hull of a little merchant steamer, for the sake of realism; yet he condemns the appearance of the wheels of a locomotive which, for all he knows, might have been intended to be a replica of a hard-working big sister which had just undergone repairs similar to those quoted above! It was also pointed out that no attempt was made to represent the tyre joint on the tender wheels. To the best of my knowledge and belief, there is no attempt to show a tyre joint on any full-sized locomotive now running, for the simple reason that the tyres overlap the rim, coming almost right down to the spokes, and only a tiny bit of the actual wheel rim shows. This stands well back from the face of the tyre, which is perfectly smooth except maybe for turning-tool marks. The recommended practice of turning a groove in the face of the rim of a little locomotive wheel, to represent the joint between the wheel rim and the tyre, is utterly and completely erroneous, as I stated when criticising this point in the wheels of the L.M.S. 0-6-0 tank, described by another writer. The correct appearance of the full-sized wheel is obtained by following the instructions that I have repeatedly given, which is to cut a tiny rebate, by aid of a parting-tool, at the junction of spokes and rim. The face of the rim is left perfectly plain, and this is absolutely correct. Any "doubting Thomas" has only to look at a full-sized engine, or turn up page 114 of A. M. Bell's work *Locomotives*, on which is illustrated ten methods of tyre fastenings. Not one of the ten has the dearly-loved but imaginary groove in the face of the tyre!!

Neglecting the literal translation of the word, a locomotive, as we understand it, is a machine built for pulling a load from here to there. It may be a train of passenger coaches, at a high speed; a heavy load of coal wagons at medium or low speed; a humble, but necessary job of shunting. Whatever the work, the designer has the same object in view; the production of an efficient machine. For this, he arranges the size and disposition of the cylinders, arrangement of valve-gear, size of wheels, type of frames and springing, and all other details, in the way he thinks will best serve the purpose. The boiler is designed to supply steam for any condition of working, with a reasonable fuel consumption, and as low maintenance cost as possible. There are other matters to be taken into account, such as the lines over which the engine will operate; but the above will illustrate the point which I wish to drive home. This is, that the whole bag of tricks has to be kept within specific limits of size, to suit the rail gauge, and the side and overhead clearances of the railway. So far, so good.

In designing, and in many cases building, my small editions, I have followed exactly the same rules that govern full-size practice, but with two disadvantages. One is, that my engine has to look as much as possible like its full-sized relations. Two, the old, old truth that Nature cannot be "scaled." Therefore, my engines are somewhat of a paradox; they *are* copies of full-sized locomotives, but are *not* copies in their detail work. They have to be arranged to suit a small rail gauge with its maximum limitations of height and width (but thank goodness there is no weight restriction!), and I have to take into account the rules of Nature, which she won't allow to be transgressed under any circumstances whatever, as I know only too well. The hundreds of successful little locomotives that have been built to my drawings and instructions, are proof that my practice is justified; and confirmation can be found in the many accounts of remarkable feats of speed and haulage that delighted builders have sent. There is no idle boasting in stating a plain fact, of which any rational human being couldn't help feeling proud.

NOT "Scale Models"

However, there is a wasp in the jampot; one that doesn't affect your humble servant in the least, but is a deterrent to many good folk who have built engines that



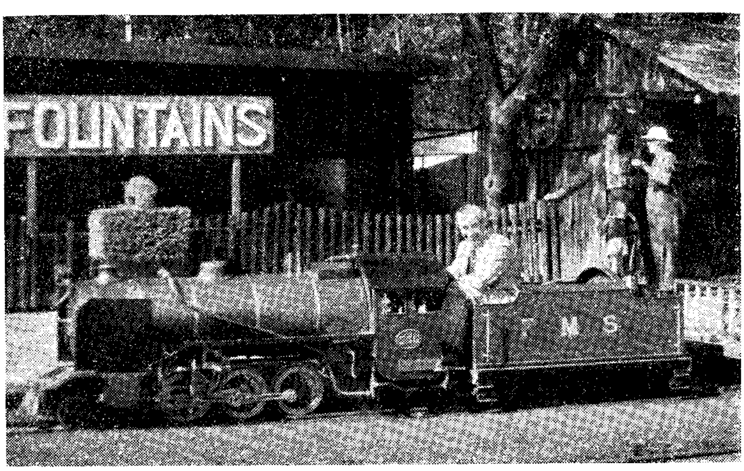
*Jack Hewitson's*Canadian-built " Invicta " gets her tender*

have been described in these notes, and would exhibit them, but for one thing. When entered in competition at an exhibition, they are either turned down altogether, or criticised in such a manner that the builder loses heart, and is sorry he ever entered the job. To put it " plain and blunt," as my old granny used to say, more importance is attached to the number of rivets in the buffer beam, or the sides of the tender, than the ability of the locomotive to steam well and pull a load continuously. It is what I call the " scale model complex," and is one of the reasons why I detest the sight and sound of the word " model," apart from the stigma of the toyshop, which will never be dissociated from it as long as human beings walk on two legs. Anybody who calls one of my little locomotives a " model," insults it.

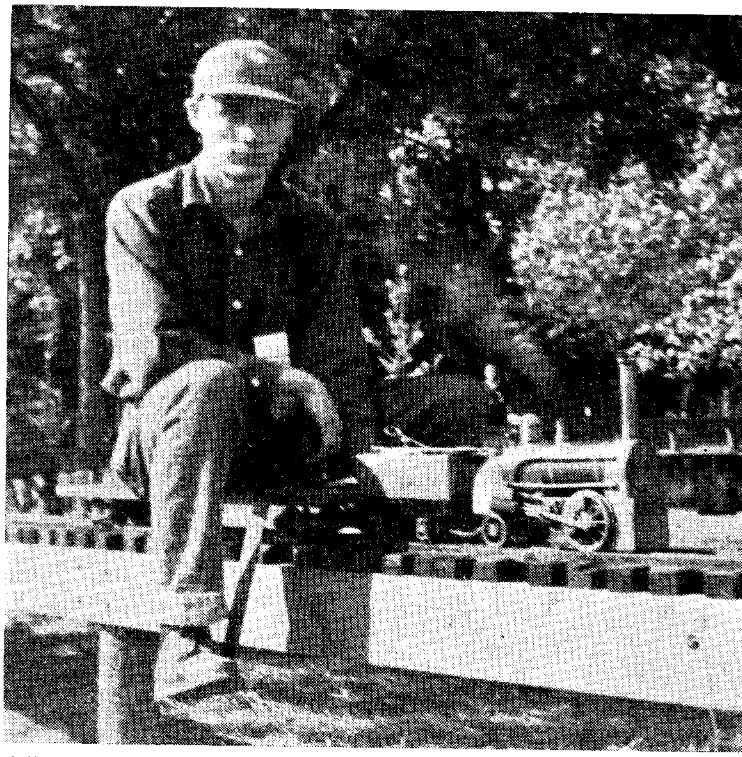
The locomotives described in these notes, are small editions of those used in full-sized practice, arranged in accordance with the rules of Nature, and the limitations imposed by rail gauge and general overall dimensions. They are intended for exactly the same purpose as the full-sized engines, which is to pull a load in an efficient manner, irrespective of the number of rivets in the buffer beam, or any other trivial detail which is of no consequence, and doesn't affect the running of the engine in any way. To quote granny once more, " them's my sentiments," and I don't care a Continental who knows it. When the good folk who organise exhibitions, veer around to the same way of thinking, and put *performance*, plus a reasonably good standard of workmanship, before trivialities, and openly announce their decision, then (and then only) will they get all the exhibits that they expect and desire, to put on their stands.

In quoting potential and actual examples, I hope that everybody interested, will bear in mind that I am still writing in the same spirit as the two drivers mentioned in the opening paragraph. I must be blunt, to drive home my points, but havn't the slightest wish to be unfriendly. First, let us consider a hypothetical case. I'll assume that two *Titfield Thunderbolts* have been entered in the competition section. One has been built to my instructions, and can steam and pull like a good 'un, in a manner of speaking; but due to hard work, the paint is a bit shabby, and the bearings have worn. Alongside her is a " scale model " type of job, built by following full-size drawings; she has the weird and most wonderful collection of brackets holding the parts of the valve-gear, the exact number of rivets in the frames, buffer-beams and tender, and other bits that you won't find in my notes. But alas ! beauty is only skin deep; the boiler won't steam for toffee-apples, the valve setting is all haywire, in fact she can't even pull her own tender, and is only fit for a toy or ornament. Yet under present conditions, exhibition judges would go into ecstasies over No. 2, and probably award the builder the championship cup, without the least hesitation. The " poor relation," by far the better engine, probably wouldn't get even honourable mention, but would probably be disparagingly criticised on account of her worn bearings and shabby appearance.

It's the same old tale, all the world over. Newspapers publish with avidity, photographs of film stars, glamour girls, society belles and what-have-you; but unless she has done something to gain notoriety, such as having quads, committing a crime, or winning a football pool, the photograph of a " plain Jane " housewife, grey-haired, rough-handed and weary-looking, would find no place in their columns. Never mind the fact that she has looked after the " old man," brought up a family, and kept her home spick-and-span through the years—that's only routine work. Just her duty; but the world would be a darned poor place without the likes of her, whilst it wouldn't suffer overmuch if there were none of the former kind. Such is life; and it is the same with locomotives. Those that do the



Sandy McInnes of Helensburgh finds a " big Little 'un " at Pretoria, Transvaal



A "Rainhill" does the job at Toronto—alas, I haven't the builder's name!

work, and earn the money, nowadays don't even get the reward of a jolly good clean up!!

An Actual Case

Some years ago, there was shown, at the Horticultural Hall, a magnificent $3\frac{1}{2}$-in. gauge Southern Railway 4-6-0 of the *Lord Nelson* type. Not only was the workmanship perfect, but the engine was an excellent performer. Everybody who saw her, whom I know, said that she was one of the finest jobs that they have ever seen. Was she awarded the Locomotive Championship Cup? Not on your life! Why? *For the simple reason that the valves of the inside cylinders were operated by Holcroft gear, instead of Walschaerts gear as on the full-size engine.* It may be news to many readers, that when the plans for the *Nelsons* were being got out, the provision of Holcroft gear for the inside cylinders was discussed; why it was not adopted, has nothing to do with these notes. However, the builder of the little *Nelson* decided to fit it to his engine and see how it panned out. This was stated in the entry; but no—it "cut no ice" with the judges, and the engine was turned down as being "untrue to prototype." Excuses like that, make me boil up. The cup was awarded to a 5 in. gauge engine which, in the opinion of many people, including your humble servant ("speak the truth and shame the devil," says the old saw) was much inferior to the *Nelson*. It not only had constructional and detail faults, such as too high cab and too low tender, but when tried on a club track on the following Sunday, it put up a very poor performance, one cause of which was badly-blowing piston-valves. I might add, in common fairness, that one of the judges at that particular exhibition has never officiated since, and never will!

What Might Have Been

Some of my correspondents who have only become readers during the last few years, often say that they think it strange that my own locomotives are never shown at exhibitions, and ask the reason. Well, one is, that I don't seek the limelight. Another is as follows: In 1952 the "M.E." Exhibition manager suggested that it would be an attraction to have all my own locomotives on show, as they all have a history of some sort or other, and approached me with that end in view. I turned the proposition down flat; new readers may ask why, as they possibly missed a chance of seeing my handiwork. Well, again to speak "plain and blunt," I'm very much averse to the sort of criticism that would have been levelled at them. The engines are all first-class workers, built with the maximum of efficiency that I could put into them; but all are in their "working clothes," and look exactly the same as their big sisters look, when performing their daily and nightly tasks. They would appear very shabby and drab indeed, among their glamorous relations, poshed up especially for show purposes.

That, however, is only a minor detail. The sort of thing that makes me feel queer, in a manner of speaking, and prevents many a nicely-made and efficient locomotive from being placed on show, is the fuss made of so-called "faults" that don't matter a brass button. Take my *Jeanie Deans*, for an example. The first thing that the "scale-model-complex" fraternity would have spotted, would have been the type-metal number plates ("That's all wrong; they should have been brass") although the letters and figures are correct L.N.W.R. pattern; also they are inscribed "Purley Works" instead of Crewe, as she was built at Purley. The lettering on the name-plates is *painted*, instead of being engraved, though this is not noticeable at first glance. The gadget behind the chimney isn't a safety-valve on the receiver, but a snifting-valve for the H.P. cylinders ("we simply can't allow that, it isn't true to prototype"). The L.P. cylinder has the slide-valve at the side instead of on top, and the valve-gear suffers from the same complaint as that on the little *Nelson*, inasmuch as it differs from that on the full-sized engine. There are only two L.P. guide-bars instead of four, and a different type of crosshead. A mechanical lubricator is fitted. The leading wheels are not radial, have the wrong number of spokes, and thicker tyres than the driving wheels. (Moans!)

The boiler has two separate superheaters, and a totally different arrangement of steam-pipes to those used by Mr. Webb. The smokebox is circular, on a saddle, instead of having a one-piece waisted wrapper, and under it is an intercepting-valve, something that the big engine never had. The tender frame is steel, instead of wood, has a modern type of body, and different brake rigging—but I won't worry readers with any more details. The fact that the little compound has run over $2\frac{1}{4}$ miles, in the presence of a

British Railways high official, and a foreman driver, hauling my weight at a high speed, *without touching the fire*, which is the equivalent of hauling a 320-ton train from Euston to Bletchley at 90 m.p.h. without the fireman picking up his shovel, doesn't matter a (deleted by censor). Bless your hearts and souls, the "faults" detailed out above, are more than sufficient to blast the engine's chances of shining as an exhibition star; and I've too much respect for the wee black lassie's feelings, to let her hear any disparaging remarks !

"Britannia's Little Mum"

Take another example, my 4-6-2 *Tugboat Annie*. I designed and built her for two principal reasons, one being to show what *could* be done to answer the driver's prayer, and the other to show an antidote to the first of the "spam cans," which had just made its debut on the Southern Railway. It was named *Channel Packet*, and was promptly nicknamed the "Flannel Jacket" by the enginemen. It was such a howling success that for a long time it could only be entrusted with goods trains, and the boys said that the brake-van always needed loading up with spare parts every time it went out ! It stands well to the credit of Mr. Riddles and his merry men, that they eventually licked the class into something like good shape, and it was SOME job, you can take that from Curly; but even now, though the engines can pull and run, it is at enormous cost for fuel and maintenance.

However, returning to *Tugboat Annie*, nothing like her had ever been seen on any railway before. She was built to the limit of size, with a huge boiler, four cylinders, 135-deg. eight-beat crank setting, Mr. Holcroft's own specially-designed valve-gear for the inside cylinders, and all the latest improvements, plus a few "anticipations." Though only a $2\frac{1}{2}$-in. gauge job, on her very first test run she hauled, without much effort at a high speed, a load consisting of the late Transport Supt. of the adjacent Council depot, two of his lorry drivers, the Highways Inspector, and your humble servant, on three cars. Now, had I exhibited her as requested, she would have been disparagingly referred to as a "freelance" job, not worthy of consideration among the "scale models." "Freelance" is a stupid and meaningless term, as applied to little locomotives, for the simple reason that *every new full-sized design is a "freelance" in exactly the same meaning*, viz.: that it is a copy of no existing type of engine. But the interesting and intriguing part is, that the full-size *Britannias*, which appeared years after, are similar to *Tugboat Annie* in many respects, so that she has earned the nickname of "*Britannia's* little mum."

Cut It Out !

To sum up, if the organisers of any exhibition want to encourage builders of little locomotives to show their handiwork, they will have to cut the "scale model" complex clean out of it, concentrating on efficiency plus a reasonable standard of workmanship. If a little locomotive bears a good resemblance to its full-sized relations, is well made, with properly-fitted parts proportioned to the size of the engine, and the plate-work doesn't look as though it had been out in Korea, and above all, can steam and pull in the manner usually observed among efficient locomotives, then—what the heck does it matter if the wheels have one spoke too many or too few; that there are slotted screws in certain places where bolts are used in full-size; that the valve-gear isn't the same as big sister's; that the "pimples" are too few, or missing—and so on *ad infinitum* ? Encouragement, not unnecessary criticism, will bring the engines to the exhibition stands; give the builders a meed of praise for their efforts, instead of the everlasting fault-finding, for trifling discrepancies as mentioned above. I know what I'm writing about—I haven't been in correspondence with locomotive-builders all over the world, for a matter of nearly thirty years, without learning something.

One final suggestion. A track should be provided at the next "Model Engineer" Exhibition, by the organisers, and *in charge of an entirely independent superintendent*; the latter should preferably be an old driver who has done a bit of locomotive building himself, in the small size. On this track, the builders of locomotives exhibited, could demonstrate the prowess of their handiwork, preferably by giving free rides to the kiddies. This would not only show that the engines could actually "do their stuff," but would be an added attraction. The engine which qualified for the Championship Cup would have to prove that her beauty was a little more than skin deep

For the BOOKSHELF

Model Railways, by Henry Greenly. Revised by Ernest A. Steel. (London: Cassell & Co. Ltd.). 204 pages, $5\frac{1}{2}$ in. by 8 in. Illustrated. Price 12s. 6d. net.

Close on thirty years ago, in 1924, the late Henry Greenly produced the first comprehensive book devoted exclusively to model railway engineering; it quickly established itself as the recognised "text book" on the subject, and it gave a great impetus to the development of what is now a popular and widespread hobby; during the following fifteen years, some revised editions of the book appeared, and then the war impeded further activities in this field. Now, however, Mr. Ernest A. Steel has issued an entirely new edition of the book. The text has been rewritten and brought into line with advancements that have been developed and adopted generally by model railway enthusiasts during the past ten years or so, and the result is an informative and helpful book for which there is certain to be a big demand.

The text, compared with earlier editions, has been compressed into twelve chapters and deals chiefly with such matters as planning model railways; permanent-way; signalling; model railway architecture, and rolling stock. In other words, it is the engineering aspect of the hobby and the basic technical information that receives the most attention. There is, however, a considerable amount of descriptive matter backed up by excellent halftone illustrations. Drawings, diagrams, plans and tables will be found in profusion, and it is interesting to note that the original drawings for the present book have been made by Mr. Greenly's daughter, Mrs. E. Howard Steel. We commend the book to the attention of all model railway enthusiasts, as the range extends from "OOO" to 15-in. gauge.

Boiler Joints

By H. E. White, B.Sc.

— SOME FACTS AND FIGURES

WHERE the joint clearances are larger, or of a varying nature, one of the alloys having a wide plastic range should be chosen. The most interesting of these are Sil-fos and Argo-flo, with plastic ranges of 55 deg. and 46 deg. respectively. Both these alloys can be applied to joints with gaps as wide as $\frac{1}{8}$ in. (this is no exaggeration—I've done it often) and they will form a perfect joint, owing to the ease with which a fillet can be built up whilst the metal is in the plastic condition. Whilst Sil-fos, which is a self-fluxing phosphorus alloy, is less ductile than Argo-flo, the makers recommend its use for joints which have to be worked, hammered or bent after brazing; it does not show a low ductility figure as the other phosphorus alloys—Cuprotectic or Silbralloy—owing to its silver content.

B6 is another very useful and relatively cheap silver alloy with a wide plastic range and a comparatively high melting point. It can be used for every joint in a boiler, and I have even used it for brazing super-heater heads at the firebox end, where it has stood up to working conditions as well as a spelter-brazed joint.

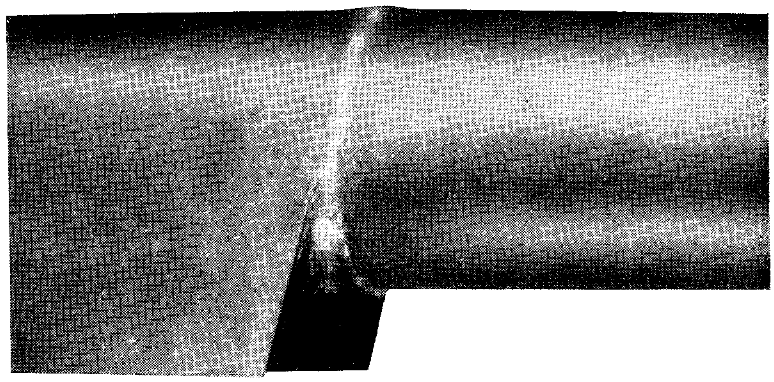
Now a word about Silbralloy and Cuprotectic. These contain phosphorus, and are attractive in that they are self-fluxing, very fluid when melted, and *cheap*. They penetrate fairly closely fitting joints quite easily, but (and this applies particularly to Cuprotectic) they can hardly be regarded as more than joint fillers owing to their low ductility. Silbralloy, however, has three times the tensile strength of Cuprotectic, and ten times the elongation, so that they ought not really to be classed together. This is well shown by the fact that Cuprotectic is supplied in cast sticks, whilst Silbralloy can be rolled or drawn into strips of 0.050 in. thickness, and rods of $\frac{1}{8}$ in. and $\frac{3}{16}$ in. in diameter. The makers point out that tensile tests on butt joints with copper bars, made with Silbralloy, show that the joint is as strong as the bar itself, and in fact that fracture at the end of the test took place in the copper bar and not in the actual joint. They also say, however, that this alloy should not be used if there is any great amount of cold working after brazing.

To return to Cuprotectic, its brittleness makes it very unsuitable for the majority of boiler joints. It has, however, three attractive features: it is self-fluxing and very fluid when melted, it has a low melting point, and it is very cheap—an 18-in. × $\frac{1}{8}$-in. rod costs only 8d., I believe. For a lapped joint (Fig. 5) it could be used quite safely, but we rarely use this type of joint in boilers. I suppose it would be possible to design a boiler with joints suitable for Cuprotectic brazing, but the idea has never appealed to me. I have used this alloy, however, for specialised purposes. Many years ago, I discarded screwed stays for the firebox sides, using instead ordinary $\frac{3}{16}$-in. copper rivets inserted in plain drilled holes as shown in Fig. 7. Both ends of the rivet are brazed with the torch flame. When I first used this method, Easy-flo was the only suitable alloy with which I was acquainted, but its cost was a serious disadvantage. An experienced welding demonstrator recommended the use of Cuprotectic for this job, so I bought some and tried it on a few trial joints. Before using it on the stay heads, I made up a testing rig (Fig. 6) which enabled me to test the rivet-stay to destruction. It consisted of a $\frac{3}{8}$-in. steel plate with a $\frac{3}{8}$-in. hole in it. A piece of $\frac{3}{16}$-in. copper rod was pushed through a hole in a piece of 13-s.w.g. copper sheet, and a fillet of Cuprotectic formed round it on one side, as shown. The copper sheet was placed underneath the steel plate, with the $\frac{3}{16}$-in. copper rod projecting upwards through the $\frac{3}{8}$-in. hole. A steel lever 4 ft. long was fitted with a cross-drilled bolt to act as a clamp for the copper stay-rod, and by means of this lever a very heavy tensile stress could be applied in an upwards direction. I expected that the $\frac{3}{16}$-in. copper rod would break under the strain, if the joint held. What actually happened was that

Fig. 5. Lapped joint in copper sheet

the rod held, and a disc of the copper sheet was torn away, and came through the hole in the steel plate, *the Cuprotectic joint remaining intact.* I concluded that this was far more strain than any boiler stays would have to stand and the new boiler was duly stayed with copper rivets and Cuprotectic, which gave satisfactory service in use on the track.

This alloy is also useful for patching up cracks or blow holes in bronze-welded joints which may



Throat-plate and wrapper seam bronze-welded. Both these joints are plain butt-joints

Concluded from page 614, *November* 19, 1953.

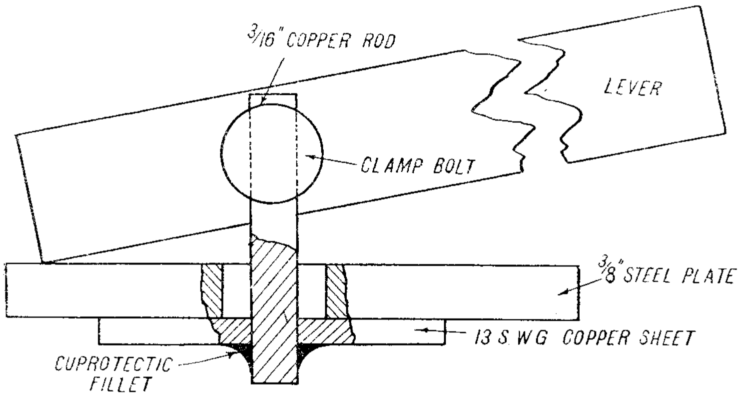


Fig. 6. Testing rig for copper stays

show up as leaks when the boiler is tested (oh yes—we're all capable of making mistakes). Such faults as leaks around tube-ends, foundation rings, firehole rings, etc., can be very rapidly and effectively corrected by heating up locally with a small tip (say No. 3) and applying the Cuprotectic rod as soon as a dull red heat is reached. Two important points should be noted. This alloy, as well as any of the other phosphorus alloys, is only self fluxing *on copper*. When any bronze or silver alloys are present, e.g. when a previously bronze-welded joint is being repaired, ordinary low-melting-point flux should be used. Another very important point in connection with Cuprotectic is that it must not be overheated. The joint should be heated to the necessary temperature before the rod is applied. It should become fluid immediately and flash over the joint. The torch flame must then be removed at once, otherwise the melt will become overheated and porous. When this happens I have found no way of correcting it; if further heat is applied in order to add further joint-metal, the original deposit becomes fluid and boils long before the parent metal is hot enough to make a satisfactory joint. The only way is to chip off the spoiled metal and start afresh.

Since this boiler was made, I have used these rivet-stays on half-a-dozen other boilers, but have brazed the stay-heads over with B6, Easy-flo and Sil-fos—the last named being delightfully easy to use. I should imagine Argo-flo would be ideal for this purpose. The method has several advantageous features over the more usual screwed stays with nutted heads. It saves a great deal of time owing to the elimination of screwing and tapping, the stays are not weakened by threading, and the silver-soldering or welding treatment of the stay-heads makes the job permanent under any conditions—even if the boiler runs dry.

In one $3\frac{1}{2}$-in. gauge boiler ($4\frac{3}{4}$-in. barrel, 2 ft. long) which I made some years ago, I used ordinary plate stays to the firebox crown, and decided to braze the difficult joint, where the girders join the outer firebox wrapper, with Cuprotectic. A couple of lengths of the cast rod were placed along each joint, and the joints were heated on the side remote from the rod until the alloy "sweated" right through. This boiler was subsequently tested to destruction after some years' use —for a reason which does not concern us here—and I found that the girder-stays *pulled down the wrapper* with the firebox crown; the Cuprotectic fillet did not fracture.

It will be seen, then, that the range of welding and brazing alloys available today enables the boiler maker to choose a suitable medium for making each of the different types of joint in his boiler. No longer is it either necessary, or wise to bronze-weld the whole boiler or for that matter to silver-solder it. Silver-solder is wasted on the back-head, being expensive and unnecessary for this joint, whilst bronze-welding would certainly be difficult for the tube-ends in any but very skilled hands. The table below shows which alloys are suitable for the various joints in a locomotive-type boiler.

The best method of jointing copper plates, bearing in mind strength, ductility and cost, is bronze-welding. It has, however, two serious drawbacks; the high temperatures necessary, and the skill and experience which are essential to do the job

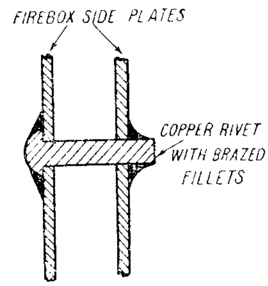


Fig. 7. Section showing copper rivet used as firebox stay

satisfactorily. Lack of experience can be offset to a certain extent by correct technique, mainly displayed in the design or choice of the most

Joint	Alloy (in order of preference)		
	1	2	3
Throat-plate (butt joints)	Argo-flo	Sil-fos	Bronze (Sifbronze or Brazotectic)
Firebox plates (flanged joints)	Bronze		
Tube ends:			
Firebox	Easy-flo	Sil-fos	
Smokebox	Easy-flo or Argo-flo	Sil-fos	B 6
Backhead (flanged joint)	Bronze	Argo-flo	Sil-fos
Front tube-plate (flanged) if done before tube-ends	B 6		
Foundation ring	Argo-flo	Sil-fos	B 6
Stay heads	Sil-fos	Argo-flo	Cuprotectic

In the above table the cost of the alloy has been treated as an important consideration.

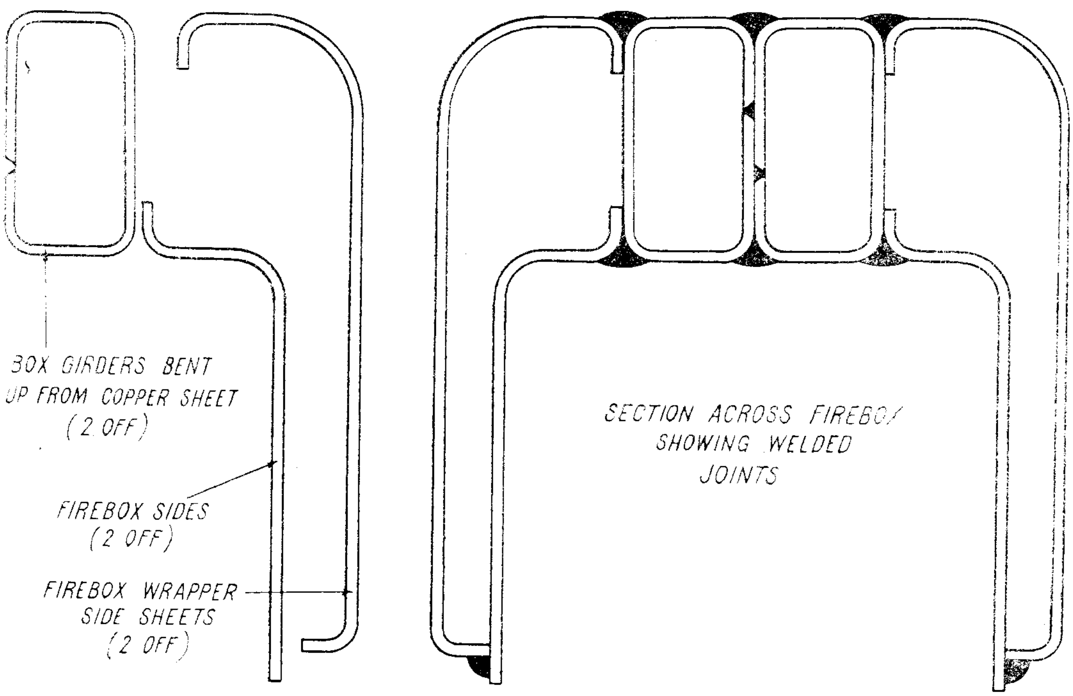


Fig. 8. Diagram showing construction of bronze-welded firebox

suitable *type of joint*. Only too often it is not advisable, or even possible to adapt the bronze-welding technique to a particular joint. Therefore, if bronze-welding is to be easy and successful the *joints must be designed for the method.* The ideal joint for bronze-welding, as shown in the textbook (Fig. 3), is one in which the edges are bevelled to provide a trough, the entire *surface* of which can be heated to ensure that the welding bronze will adhere to the metal (" wetting " or " tinning " it) before the fillet is laid in. Unless butt joints are going to be used—and I see no reason why they should not, bronze-welded butt joints being much stronger than the sheet copper itself—then our flanged joints must be made to suit bronze-welding, i.e. they must form open troughs to take the bronze fillet. I have recently designed and built a boiler for my new engine, *Arthropod*, which illustrates this point.. Because the ideal bronze-welded joint is a filled trough, the firebox was designed to make full use of this kind of joint throughout, both inner and outer boxes being built up as one unit. Reference to the diagram Fig. 8, will show that the assembly consists of six pieces of copper plate; two are hammered around a rectangular wooden former with well-rounded edges to form long box-girders, and the other four are bent up to form the inner and outer firebox sides, the firebox crown, both inner and outer, being formed by the box girders. Every joint in this assembly was a simple trough-filling operation, using the bronze-welding technique, even the foundation ring—which is absent ! —being similarly formed. Backhead and throat-plate were made with well-radiused flanges, and were bronze-welded in place, the entire firebox assembly being thus welded up with easily accessible joints, all facing outside.

A word about fluxes. The boiler maker who has been used to ordinary blow-lamp brazing with borax or boron compounds, and found these fluxes entirely satisfactory, might think that what he may regard as " fancy " fluxes may be an unnecessary expense. An examination of the principles governing their use, either from experience at the bench or from a perusal of the manufacturers' pamphlets, will soon show that such is not the case where the oxy-acetylene flame is used, and even, in the case of the silver alloys, where more moderate heating methods are used. The fluxes recommended for the bronze-welding technique have been specially developed—just as the alloys themselves—to withstand the very high temperatures in the hottest region of the flame. If this portion of the flame is allowed to impinge on the copper, it is only too easy to oxidise the surface so that the bronze will not " wet " the surface, and the flux is designed to protect the metal, and remove oxides, under severe temperature conditions.

With the silver alloys—and particularly those of the low-melting type such as Easy-flo and Argo-flo—the alloy will melt at a lower temperature than ordinary borax fluxes, which are therefore, quite unsuitable. The special fluxes developed by the makers of these alloys melt at a lower temperature than the alloys. In fact, the correct technique is to apply the flux, mixed with a little water to form a cream, to the work, and heat the joint until the flux melts and runs around it; this is an indication that the correct temperature has been reached for the application of the silver-solder. Such low-temperature fluxes are also suitable for use with Cuprotectic, Silbralloy, or Sil-fos when the joint already contains other metals than copper.

IN THE WORKSHOP

BY DUPLEX

MAKING A CIRCULATING PUMP

CIRCULATING pumps are made to serve many useful purposes, but in the workshop the most usual application is, perhaps, to furnish a supply of cutting fluid in connection with machine tools. The advantages of supplying a continuous stream of cutting fluid to the tool, when machining work in the lathe, are well known, particularly with regard to longer tool life and an improved surface finish.

For this purpose, the fluid can quite well be delivered at low pressure, for it is the volume of the supply that really counts in preventing overheating, and a film of fluid is usually sufficient for maintaining lubrication of the tool's cutting edge.

An easily-made pump of the low-pressure type is that known as a centrifugal pump; here, a disc with radial vanes, rotating at high speed, delivers a continuous output of oil or other fluid, mainly as a result of the centrifugal force set up, so that the rotor need not be made a close fit in its cylindrical casing.

A vane pump, on the other hand, is fitted with vanes sliding radially in the rotor disc in order to form a fluid seal and, by this means it is possible to deliver the output at comparatively high pressure.

A third variety of rotary pump, the gear pump, consists of two gear wheels running in mesh in a closely fitting pump body; the fluid is forced round the outer edges of the pinions and, again, a high-pressure output is obtained.

Where a circulating pump is fitted, the swarf formed in a machine tool is carried away by the stream of cutting fluid, but metal chips may cause damage if any escape the filter and reach the interior of a pump with closely-fitted working parts. With the centrifugal type of pump, however, there is little danger of damage being caused in this way, as the working clearances can be made quite large and the pump, if run at high speed, will still act efficiently as a fluid circulator. For this reason, it was decided to use a centrifugal pump for supplying cutting oil to the machine tools in the workshop.

Building the Pump

The body *A* was machined from a solid piece of duralumin by first mounting the material in the four-jaw chuck, and then boring out the central cavity to a diameter of $1\frac{3}{4}$ in.

Next, the part was set off-centre to enable the discharge chamber to be machined to shape with a milling cutter mounted in the lathe milling attachment. The work was then held by its bore on the external faces of the chuck jaws for contour-milling the outer surface of the pump body. This milling operation was carried out partly as an experiment to test further the capabilities of the milling attachment recently described in these pages. It was found that an end-mill, cutting over the full width of the body, gave a very satisfactory finish, as can be seen in the accompanying photographs.

No doubt, recent visits to an aircraft factory prompted the decision to lighten the body by machining away all surplus metal; but, on the other hand, where weight is not important, a component with flat surfaces and without corners is usually more easily kept clean.

The set-up for contour-milling the body is shown in Fig. 5; here, the milling attachment is mounted on the lathe bed with the end-mill set to operate horizontally, and the work is rotated by means of the dividing head, engaging a change wheel secured to the tail of the mandrel. For many years past, we

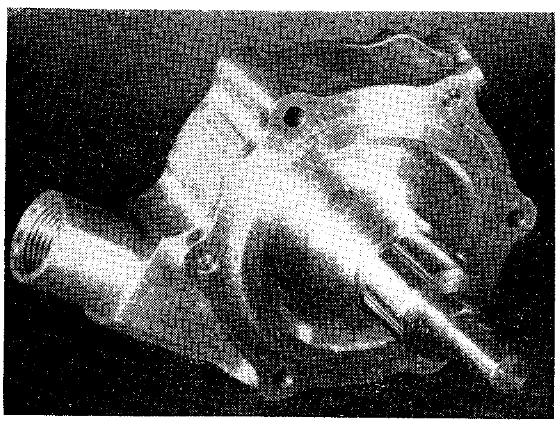


Fig. 1. ***The** finished pump, showing the spindle gland*

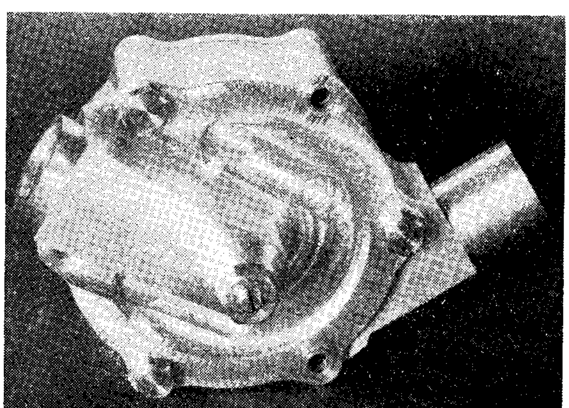


Fig. 2. *The pump seen from the inlet side*

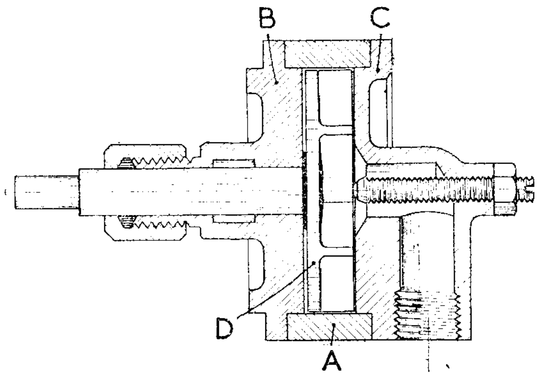


Fig. 3. Sectional drawing of the pump, showing: A—the body; B—the gland plate; C—the cover plate; and D—the rotor

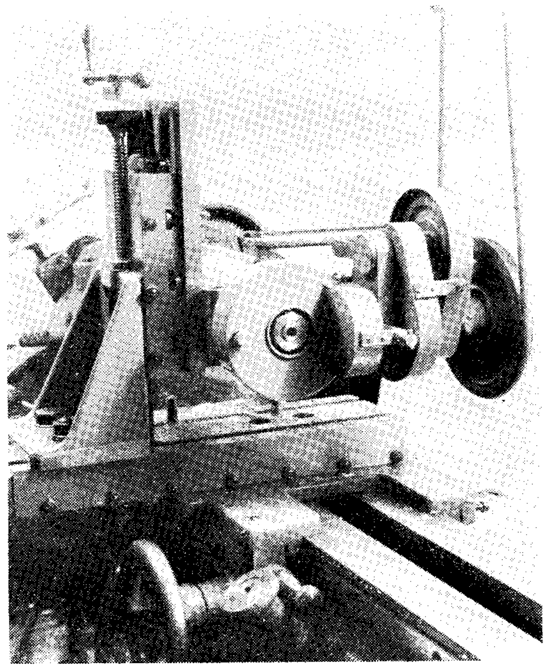


Fig. 7. The lathe set-up for milling the body and end plates

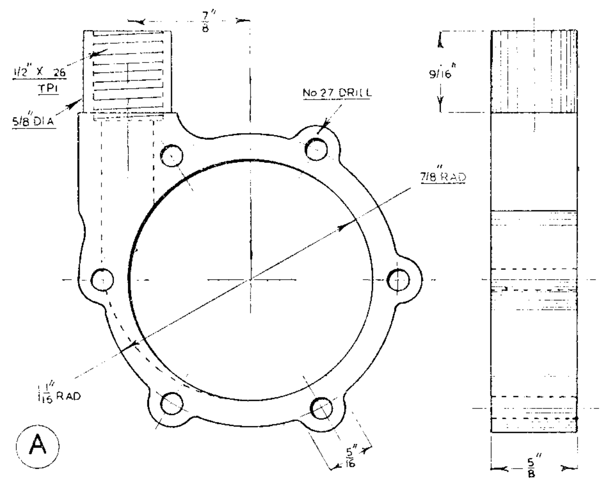


Fig. 4. Details of the pump body

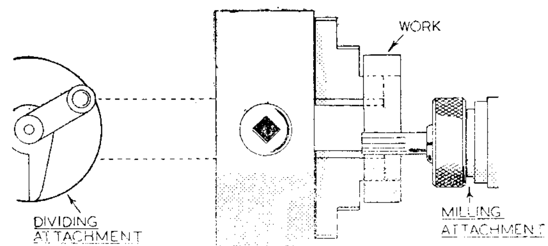


Fig. 5. End-milling and indexing the pump body

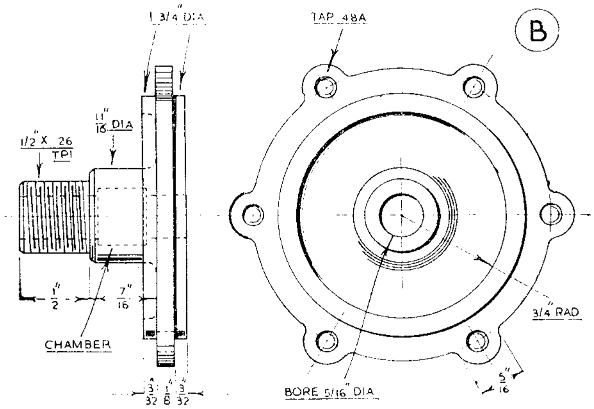


Fig. 8. Details of the gland plate

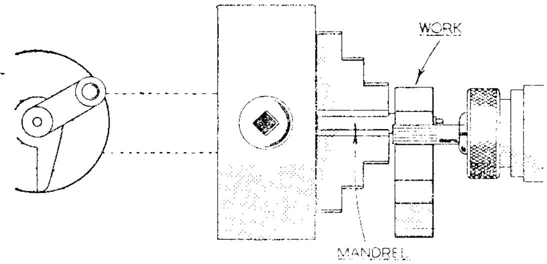


Fig. 6. Contour-milling the bolting lugs

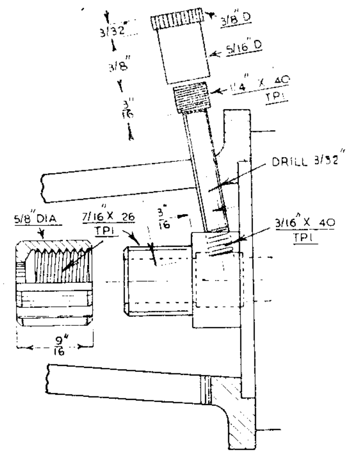


Fig. 9. The packing gland and lubricator

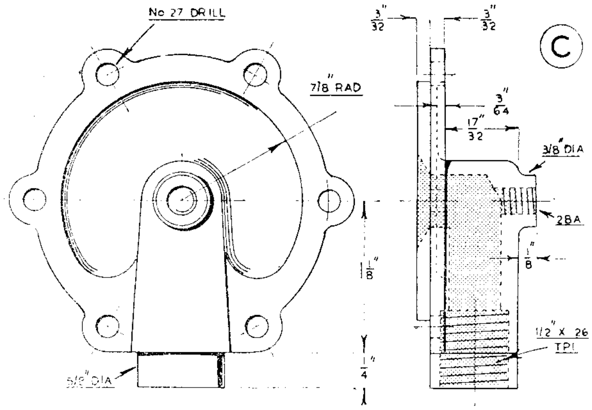


Fig. 10. The cover plate and inlet port

have used this method of circular milling, and it has the advantage that the movement of the work, in either direction, can be accurately controlled by making use of the fingers of the dividing attachment to serve as work stops. The centres for the six bolt holes should be accurately indexed and then drilled, for this will allow the inlet and outlet nozzles of the pump to be set in any position to line up with the feed pipes.

These holes were used, in turn, for mounting the body when carrying out the radial milling operations on the bolt lugs.

For this purpose, a length of mild-steel, gripped in the chuck, was shouldered down and threaded to form an arbor for bolting the body in place. Surprisingly enough, even with this slender form of arbor, a good finish was obtained on the work.

The outlet spigot was machined by securing the part to an angle-plate, mounted on the lathe face-plate.

The Gland Plate—B

This is a straightforward machining job, but it should be noted that three of the bolt holes are threaded 4 B.A., and the remainder, spaced at 120 deg., are drilled to the clearing size for the attachment of a drive unit.

The packing gland is formed in the usual way, and the face of the gland spigot should be counter-bored for a short distance to provide a housing for the packing material.

The gland spigot is also drilled and tapped at an inclined angle for the lubricator assembly. The lubricator pipe is machined from a length of steel rod, and a screw-driver slot is formed at the upper end to save having to use hexagonal material to afford a spanner hold.

The lubricator feeds grease into an annular recess machined within the bearing. No bearing bush is fitted, as the pump is designed for direct coupling to an electric motor.

The contour milling on the gland plate can be carried out by mounting the pump body in the lathe chuck and then bolting the cover in place.

The Cover Plate—C

As no casting was available, this part was also machined from a solid piece of duralumin.

The boss forming the pump intake was shaped by first sawing away the surplus metal and then milling it to the finished form, either when held directly in the chuck or by using the pump body as a mounting. The inlet spigot is machined and tapped with the work mounted on an angle-plate, secured to the lathe faceplate.

Where the pump is set to work in a vertical position, a foot-step bearing is fitted to take the weight of the rotating parts, as well as any thrust arising from the drive coupling.

(Continued on page 639)

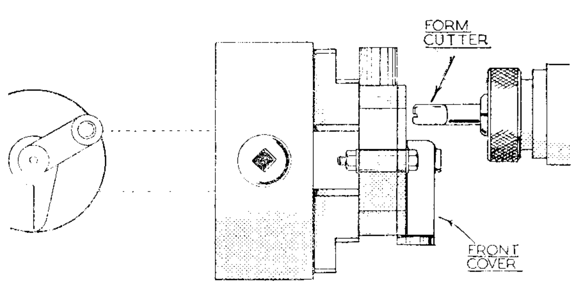
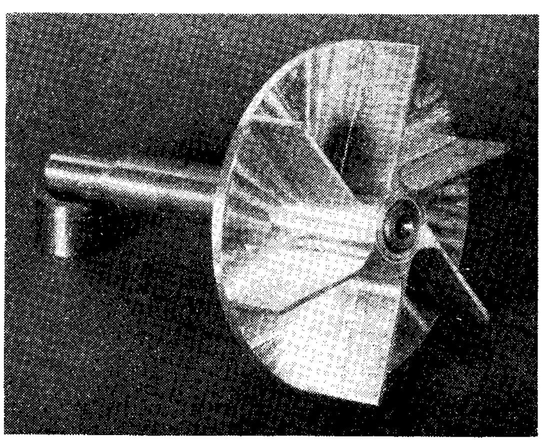


Fig. 11. Recessing the cover plate with a slotting-mill



Right: Fig. 12. The rotor mounted on its spindle

READERS' LETTERS

● Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

A RE-PAINTED BURRELL

DEAR SIR,—This photograph shows a three-speed 5-ton Burrell tractor, No. 3718, which I have painted. This engine is owned by my brother and has been in constant work up to last year; then he drove it to my place to be painted for preservation. I have painted her the maker's colour and lined her to their style, except that on the flywheel I have added some of the showman's pattern. I am a coach painter, and have had over 37 years with these machines. I have painted nearly every make of tractor, roller, and steam wagon in my time, and I am very sorry to see so many going for scrap.

I am a regular reader of THE MODEL ENGINEER and I read with interest, Mr. W. J. Hughes's article on steam in the October 15th issue, in which the Aveling & Porter that was built in 1873, is shown. I have Aveling's catalogue of their first traction engine built in 1861 and their ploughing engine of 1871; also of their rollers, 1867 to 1922; I also have a catalogue of Burrell tractor, steam wagon, and Garrett over and under type wagon.

Yours faithfully,
Holsworthy. W. MOORE.

AN IMPROVISED LATHE STEADY

DEAR SIR,—We recently required a 12 in. × $6\frac{1}{4}$ in. o.d. mild-steel round bored to a depth of 3 in. one end, and screw-cut 4 t.p.i.

After several local engineers had turned the job down, as their 14 in. lathes had no steadys large enough, a friend (Mr. A. Ingram, 1, Chelford Road, Bromley) undertook the job *at home on his $5\frac{1}{2}$ in. Southbend.*

This was executed by being turned in the chuck with the weight laying on two beech wood "bearings" well lubricated. The "bearings" were clamped to lathe bed and two 1 in. wide mild-steel straps were screwed to the "bearings" and over the job to prevent lift. The boring was executed upside down to prevent chatter, and at no time was any undue strain suffered by the South-bend. The whole job took 10 hours.

As the metal being turned weighed approx. 52 lb., we consider this must be a record job for such a small lathe.

Yours faithfully,
South Norwood. L. J. COOPER.

IGNITION PHENOMENA

DEAR SIR,—The letter by Mr. B. Trott (October 29th, 1953 issue), dealing with static electric charges in i.c. engine petrol mixtures, is intriguing, and I am wondering if he has "got hold of something" or not. He mentions that the mixture in the cylinder contains droplets of oil which usually carry a small charge of electricity, but he does not offer any very clear explanation of why this should be so. The idea is new to me; is it an attested fact or not? If it is, it would appear to have a bearing on other problems of carburation, applicable to all i.c. engines with electric ignition, from the largest to the smallest.

Yours faithfully,
London, W.1. JOHN H. AHERN.

SMALL BAND-SAWS

DEAR SIR,—I was interested in "Duplex's" remarks on band-saws versus jig-saws in the September 17th issue. One of their reasons for not considering a band-saw is, apparently, because of the saw blades; in Nairobi, Kenya, both wood and metal-cutting blades in widths from $\frac{1}{8}$ in. to $\frac{1}{2}$ in., of various tooth pitches, are obtainable by the foot. If this can be done here by retailers, I see no reason why it cannot be done in England.

As a practical model engineer with experience of both jig-saw (which I sold some years ago) and band-saw, I consider the band-saw the ideal model engineer's tool for quickly cutting up metal sheet, bar and tube, and also for the odd carpentry jobs which occasionally crop up. Different blades, once made up, can be quickly changed according to the material being cut. I recently cut up a 3 in. square mild-steel plough beam, and each cut, with a suitable blade, took eight to ten minutes. Although this job is a heavy one, and not likely to be encountered in the normal run of work, it does show what can be done with these tools.

Another objection raised by "Duplex" is the need for a band-saw blade to be broken when cutting circular or rectangular apertures; I find this no problem at all, as all my blades are silver-soldered with Easy-Flo and a blowlamp, and it is surprising, after a little practice, how quickly joints can be made without the necessity of the expensive electric welding appliances mentioned. In any case, it has been my experience that Easy-Flo makes a better joint than electric welding, as welding is rather inclined to make the blade brittle at the joint.

No, "Duplex," much though I enjoy and appreciate your articles (I am at the moment constructing a lever feed for the tailstock of my Myford M), I am firmly convinced the metal and wood cutting band-saw is a more practical and versatile tool for the average model engineer than either the jig-saw or the power hack-saw.

I may add that the band-saw I am now using is a home-made job, constructed without any difficulty by a friend of mine,

Yours faithfully,
Tanganyika. H. T. LEE.

A MYSTERY—STILL UNSOLVED!

DEAR SIR,—At the risk of being hauled off to the "Old Bailey," I write to say I do not believe a word that chap Oxley says in THE MODEL ENGINEER of the 29th October. His Grandfather did not take over a grappling iron mill at Dorking, because the only mill at Dorking was at Leatherhead, and that was a sky-hook factory, and Herbert Thump did not throw any bridges across "Cricklewood Broadway" because he was not strong enough.

No, Mr. Oxley, I remember your article on Square Boilers, etc., in the last Xmas issue, and I have just had it on no less an authority than Busting on Boilers (published 1831), that square boilers are not a proposition.

Incidentally, the machine in question is, as any child of 43 years knows, to hold together the holes in a fishing net while the string is tied round them. As for his machine propping open the door between the workshop, and the padded cell, according to my wife (one of the finest women I have ever married), there is no difference.

Yours faithfully,
London, S.W.16 "TEARDROP."

MAKING A CIRCULATING PUMP

(*Continued from page* 637)

As shown in Fig. 3, this bearing consists of a screw with a $\frac{1}{8}$-in. cycle ball embedded in its tip to engage in the conical centre drilled in the end of the pump spindle.

If the pump is to circulate water, the ball should be of the stainless-steel variety and the screw made of bronze. Note that in this cover the six bolt holes are all drilled to the clearing size.

The Rotor and Spindle—D

The spindle should be made first in order to serve as a mounting for the rotor when machining the vanes. If the pump is to circulate oil, stainless-steel is unnecessary and silver-steel will serve well for making the spindle. Where the direction of the drive tends to tighten the parts, the rotor can be screwed on to the spindle; otherwise, it is better to make the rotor a firm press-fit.

The spindle, with the rotor blank in place, is centred in the four-jaw chuck, and the six vanes are end-milled to shape, using the lathe milling attachment and the dividing head to rotate and index the work.

This completes the construction of the pump itself, and in a subsequent article details will be given of a self-contained drive by means of an electric motor.

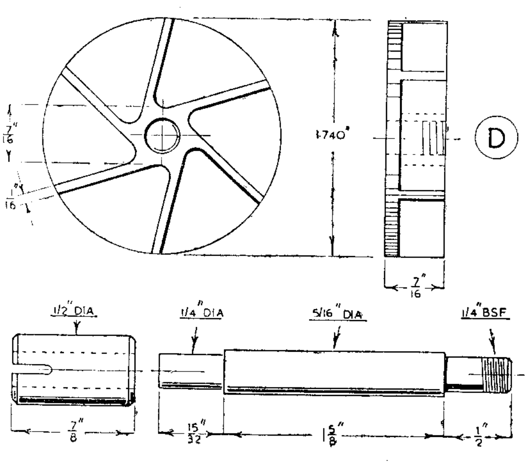


Fig. 13. Details of the rotor and driving spindle

Talking about Steam—

NO. 22. EXPANSION VALVE GEARS

By W. J. HUGHES

THE earliest steam-engines worked with a pressure of steam which was very little—only a few pounds per square inch—more than atmospheric pressure. Indeed, that was all that the boilers could stand ! And this fact to some extent accounts for the huge size and weight of the engines; in order to obtain a satisfactory horse-power, it was necessary to use a piston of large area on which the steam could exert its pressure.

But as steam of higher pressures came into use, the size and weight of engines became naturally less in comparison; or, alternatively, the power developed by an engine of large piston area was proportionately increased.

Now, with very low pressure steam, the latter had to be admitted to the cylinder for the full length—or almost the full length—of stroke. However, with higher pressure steam, it became possible to utilise its expansive properties, which (as most readers will know) is done by cutting off the supply of steam at a certain position in the stroke of the piston. The steam already in the cylinder then expands, and this expansion drives the piston for the rest of the stroke. (See " Talking About Steam . . . " for June 26th, 1952).

So, with the development of higher pressure, there came the invention of a multitude of different types of variable valve-gears, some good, some bad, and some indifferent ! Many of these exist today, but many more fell by the wayside because of defects or inadequacy, or through becoming out-dated.

Variable Expansion

In a large number of stationary steam-engines, of course, the load is fairly constant, and any variation can be dealt with adequately by the governor. A fixed cut-off is employed, obtained by adding lap to the slide-valve (as described in the article just mentioned).

The governor acts on a valve placed in the steam-pipe. If the load on the engine becomes less, resulting in increased speed, the governor will close or partially close the valve, thus throttling the supply of steam to the engine, and slowing it down.

The trouble with this system is that in *throttling* the steam, its effective pressure is reduced—try squeezing your throat with both hands for a rough-and-ready demonstration !—and hence the efficiency of the engine is lowered. It should be obvious that if the steam only commences the stroke at a lowered pressure—which in itself is inefficient—when it is cut-off its expansive properties are also correspondingly reduced. Consequently it is much better to be able to vary the position of the *cut-off* to suit the load. In this way, steam is admitted *at full pressure* until it is cut-off, and then its expansion is fully utilised during the rest of the stroke.

Expansion Valve-gears

How is it then, the tyro may well ask, that *all* steam engines are not fitted with " expansion " valve-gears ?

In the first place, where fuel is cheap—or perhaps we should say *was* cheap !—and plentiful, with adequate water supplies, the added complication and expense would not be justified. Similarly, on a small engine, especially where the load was nearly constant, the saving in fuel and water might not be sufficient to be worth-while. But where fuel and water were more expensive, or in short supply (as in marine work), or in an engine of large horse-power using large quantities of steam, or again where the load fluctuated considerably (as in railway working), the saving could be considerable, and would soon more than pay the additional cost.

So there came into being the many different types of valve-gear for road, railway and/or marine work—the Stephenson, the Walschaerts, and the Joy, to name but three—and along with them were others more suited to the stationary engine: Meyer's, Rider's, Hornsby's, and so on. Nor must we forget the infinite varieties of Corliss trip-gear (with some of which we shall deal in a subsequent article), and of other

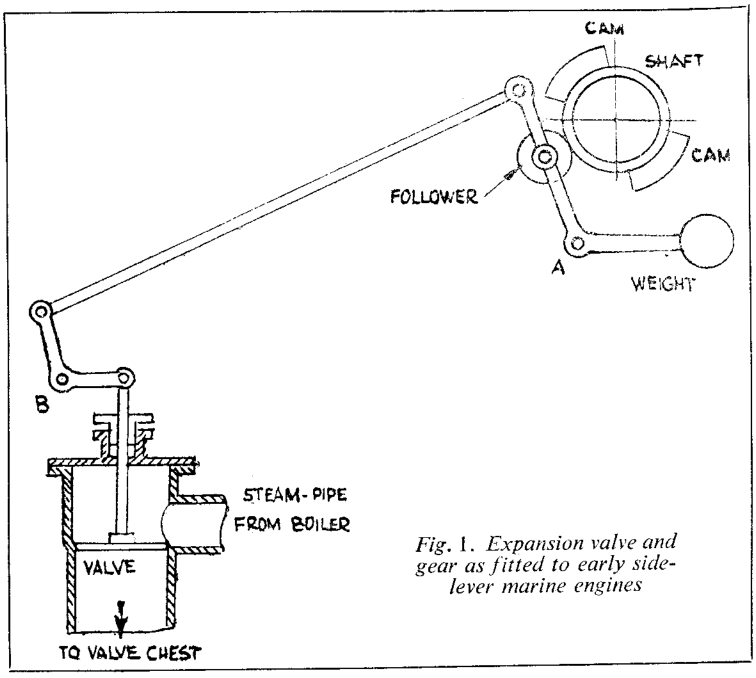


Fig. 1. Expansion valve and gear as fitted to early side-lever marine engines

types of gear developed for use with drop-valves. Oh, yes! we could fill many volumes of this journal describing 'em all!

Many of the gears, especially those for use in transport, are manually controlled, while a large number of those for stationary work are automatically controlled by the engine governor. A good example of an expansion gear controlled by *both* methods is that fitted to the Wallis and Steevens traction-engine, which I briefly described and illustrated recently in these pages.

An Early Marine Expansion Gear

In the early side-lever marine engine, a separate valve was used to work the cut-off, and Fig. 1 shows this in diagrammatic form (copied from Hoblyn's *Manual of the Steam Engine*, 1842). At this time the type of main valve, controlling inlet and exhaust, was usually either Murdock's long D-valve, or Seaward's four-port type, and the expansion valve was fitted in a separate chamber bolted to the side of the main valve-chest.

A bell-crank pivoted at *A* is oscillated by two cams mounted on the engine crank-shaft, the follower (which Hoblyn calls a "pully") being kept in contact by the action of the weight. It will be obvious that through the rod and the second bell-crank the valve is opened and closed twice in each revolution. The duration of the opening and the point of cut-off are fixed by the length of face of the cams and their position on the shaft relative to the crank itself.

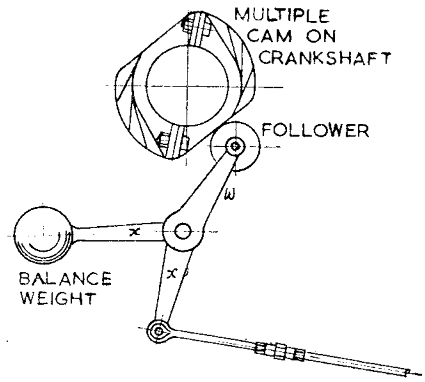
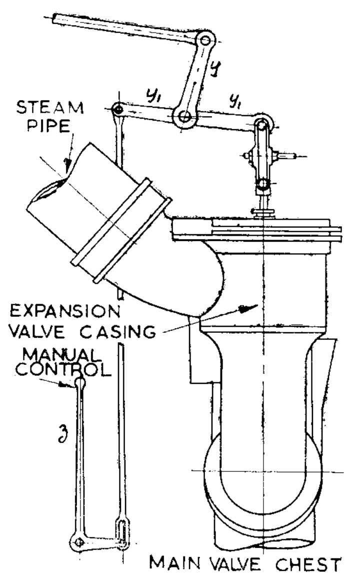


Fig. 2. Improved gear with variable expansion fitted to later side-lever engines

Of course, this type of gear only allowed of a fixed cut-off, which did not provide for any variation in the work to be done. This was soon altered, and the next drawing shows the arrangement, which I have copied from Jones' *Engineer and Machinist's Assistant* of 1847. (For the loan of this invaluable book I am indebted to my good friend E. S. Brook, fellow-member of the Sheffield S.M.E.E.).

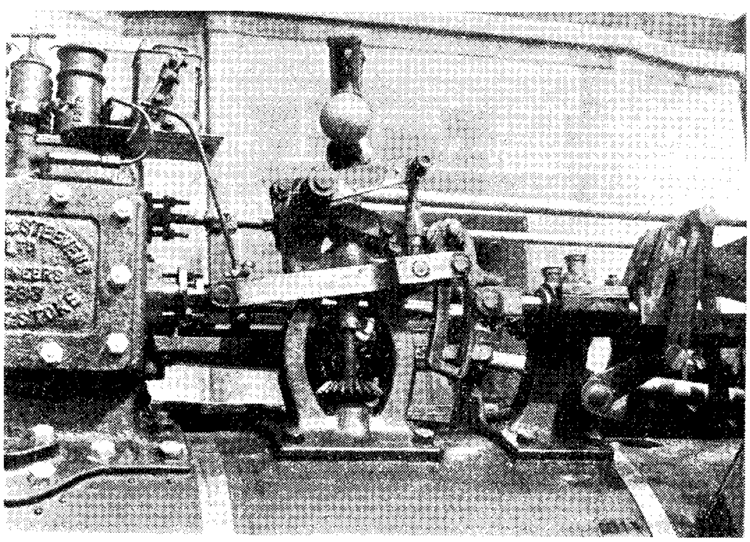
The engraving from which this copy was made is one of several illustrating side-lever engines of 145 h.p. (nominal) built by Caird & Co. of Greenock for the steam-packets *Actaeon* and *Achilles*, and also for the Royal Mail packet *Urgent*.

Apparently at first the engines did not have *variable* expansion, but it was fitted later to *Achilles—Actaeon* was lost in the West Indies—and so



was embodied in these drawings, which actually were made from the engines of the latter ship. Subsequently Caird's built engines of 225 h.p. for the well-known West Indian packets *Clyde*, *Tay*, *Tweed* and *Teviot*, which engines were almost identical in appearance and design with the 145 h.p. ones. (With the Editor's permission this is another subject I hope to deal with in detail later on, by the way).

It will be seen from the drawing that we now have a cam with five different faces, each of different length, and so capable of giving five different degrees of expansion. When the follower rests on the outermost cam-face, the expansion-valve will be open for the minimum time, but as the arm carrying the follower is moved inwards towards the engine-framing, the period of



Photograph No. 1. Wallis expansion-gear with radius arm set for early cut-off. (*See also photograph on p.* 419, THE MODEL ENGINEER *dated October 8th*, 1953)

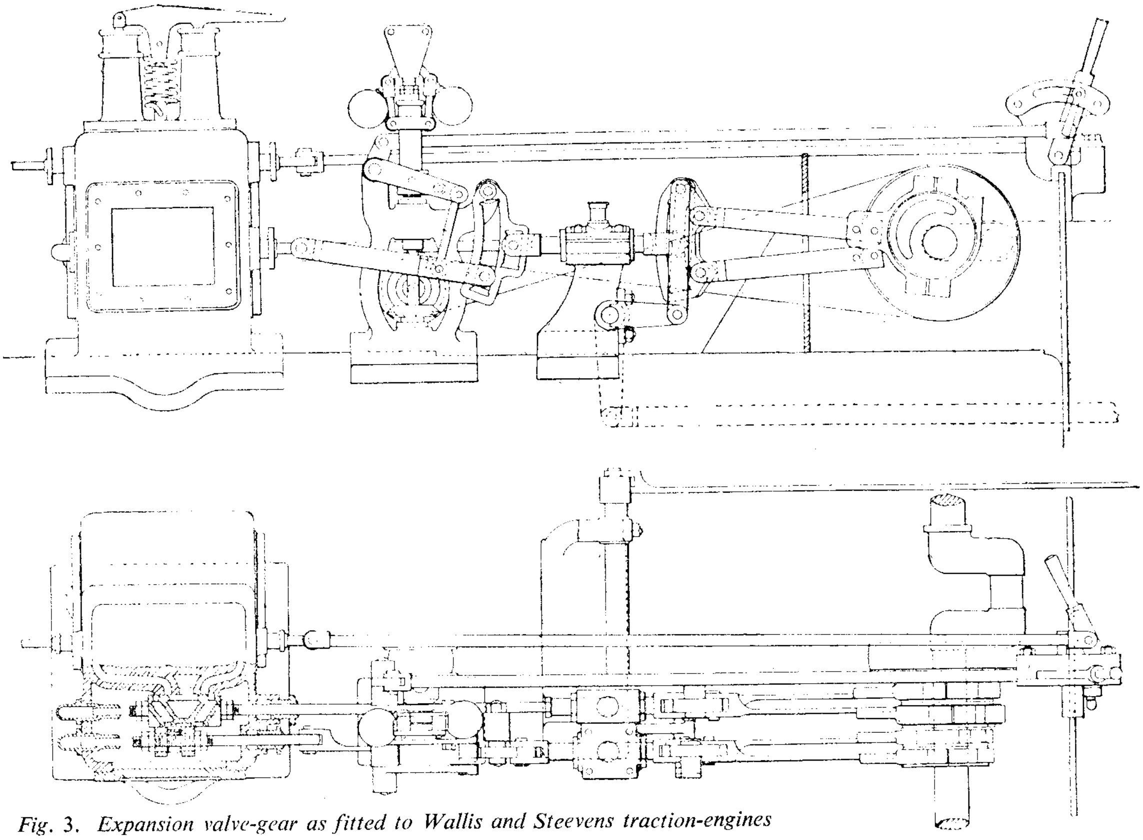
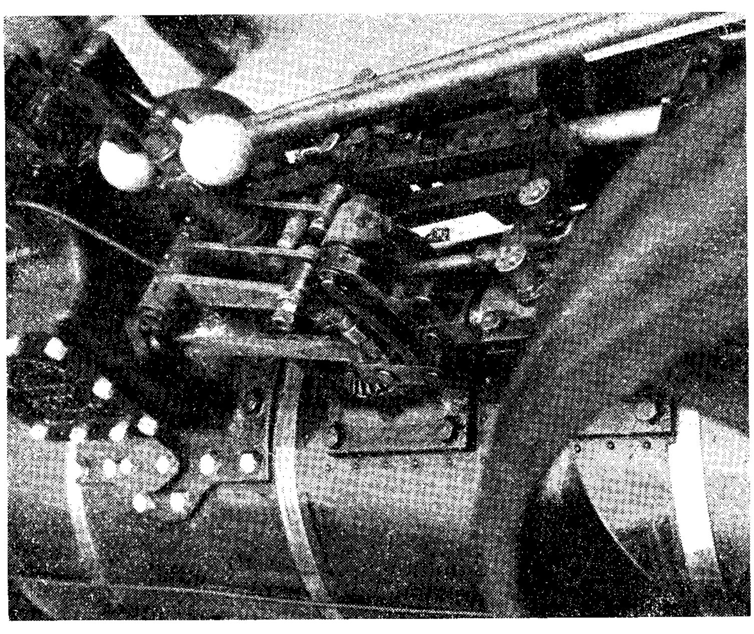


Fig. 3. Expansion valve-gear as fitted to Wallis and Steevens traction-engines



Photograph No. 2. View from the hind wheel of the Wallis expansion gear, (manual control in operation, set for late cut-off)

opening is progressively increased.

This lever (*w*) slides on a key sunk in the boss of the back lever (*x*), which is forged in one with the weighted lever, and the sliding movement of (*w*) is controlled by screw and nut. A rod of adjustable length connects (*x*) with another lever (*y*), which is fast on a spindle to which the double lever (*y*1) is keyed. One end of the latter is connected to the expansion valve by means of a pair of links; the valve is now of the equilibrium type, by the way. The other end of the double lever is connected to a manual control. Thus when lever (*z*) is moved to the right, the expansion valve is opened, and the engine receives steam for the full period. At the same time, through levers (*y*) and (*x*), the follower is taken out of contact with the cam, so that this no longer affects the valve. This type of gear, then, enables either the fixed cut-off to be used when full power is required, as in manoeuvring, or five other degrees of expansion to be used as required by conditions of speed, weather, or other circumstance.

(Continued on page 646)

QUEERIES AND REPLIES

"THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked "Query" and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Converted Rotary Transformer

I have recently purchased an ex-R.A.F. rotary transformer 220 V, a.c., converted for use as a small grindstone. Unfortunately, when much load is applied to the wheel, there is a great reduction in speed. I note the motor is fitted with one set of brushes, although there is provision for two more.

Could you please advise me of any modification I can make to increase the power output of the motor?

G.G. (Cambridge).

The great majority of converted machines of this type tend to run at high speed with very low torque, and consequently fail to maintain their speed when appreciable load is applied, as the machine was not originally designed for use as a motor.

There is little that can be done to remedy this, short of complete rewinding, the success of which might be doubtful. In any case, the reason why one set of brushes has been put out of action is that these brushes were intended to communicate the current to the low tension winding of the armature, which is not now in use. There would be no point in attempting to connect these brushes when using the machine as a motor; in fact, owing to the low resistance of this winding, it would be burnt out if mains voltage were applied.

Motor for Driving Lathe

I have the choice of two ¼-h.p. motors to drive my 3-in. lathe—one a 950 r.p.m. slip-ring motor and the other a 1,425 r.p.m. induction motor, with automatic cut-out for the starting winding.

I am not sufficiently knowledgeable in these matters to judge which of the two is likely to be the more satisfactory, bearing in mind such considerations as starting, continuous running, interference with wireless and television, etc., and I should be very grateful for some advice on the subject. Do you advise fitting a suppressor to either type?

G.R.G. (Edgware).

We should be inclined to favour the induction motor with automatic cut-out for the starting winding.

Motors of this type do not produce interference with radio or television except for a very slight click at the moment the switch contacts or the cut-out contacts operate.

In the case of the slip-ring type of motor, this should also be normally free from interference, but any slight roughness of the slip-rings, or anything which impairs perfect contact, might give rise to a current ripple and thus cause interference.

Grinding in the Lathe

It has been wisely said that grinding should not be carried out on a lathe, because grit will inevitably get into the works, with deleterious effect on the works—especially the bed.

I see, however, that watchmakers do polishing, lapping and so on with their precision lathes. Is this really sound practice? Is this because their polishing compound, such as diamantine, is too fine to damage the beds, or is it because they take good care not to allow the compound to drop on to the works?

K.A.L. (London, N.W.1.).

The use of lathes for purposes such as lapping and polishing is common, not only in the watch making trade, but also to some extent in engineering. Generally speaking, in such processes it is possible to keep the lathe bearings fairly well protected against the entry of abrasive particles, but when a high-speed grinding wheel is used on the lathe, the particles are thrown off as a fine dust, which is very difficult to keep out of places where it is not wanted.

It is this practice which is generally considered objectionable; but in all cases where abrasives are used on the lathe, it is necessary to take great care to keep them in their proper places.

The Simplest Steam Engine?

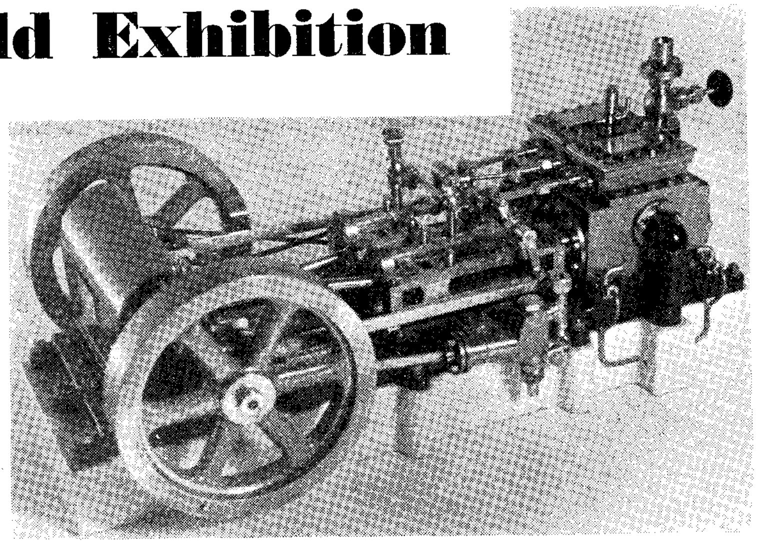
(*Continued from page* 623)

This extreme simplicity for a single-cylinder engine permits two cylinders to be employed and yet produce an engine which could be said to be simpler than one of the usual type with one cylinder. It needs but a few diagrams to explain how an engine with two cylinders can be arranged whilst employing this principle. More are not necessary in the size, because two double-acting cylinders completely eliminate dead centres. In all the cases about to be shown, the two cranks are at right-angles, and the type of cylinder is that with flanged branch, as in Fig. 10. Fig. 11 shows in outline diagram form the plan of an engine having a cylinder at each end of the shaft, with a flywheel between the bearings. The cylinders may be horizontal, as shown, or vertical. Such a design is suitable only for a belt or geared drive; the shaft cannot be direct-coupled to anything. Fig. 11a is an elevation and axial view of the U-form bearing bracket to which the two cylinder branch flanges are connected and which acts also as a flat holding-down base.

The shafts for twin-screw model ships nearly always have to be geared together to keep the speeds of the propellers the same, and single-cylinder engines have been made to drive the two geared shafts at once. Fig. 12 is a plan, showing two geared flywheels driven by two cylinders of the present design, arranged vertically side by side. In both the engines of Figs. 11 and 12, if steam goes to the same port in both cylinders, the pistons must be right- and left-handed as regards the grooves, and the engines will run in the opposite direction if the pistons are changed over in their cylinders. The same arrangement of cylinders can be used to drive a single shaft through gearing, as shown in Fig. 13, which is a plan with the gearbox in section. The rest is left to readers' ingenuity.

Huddersfield Exhibition

Reported by " Northerner "



Harry Booth's fifty-fourth model, as usual, was of an interesting prototype—a twin-cylinder " fixed agricultural engine " of 1876

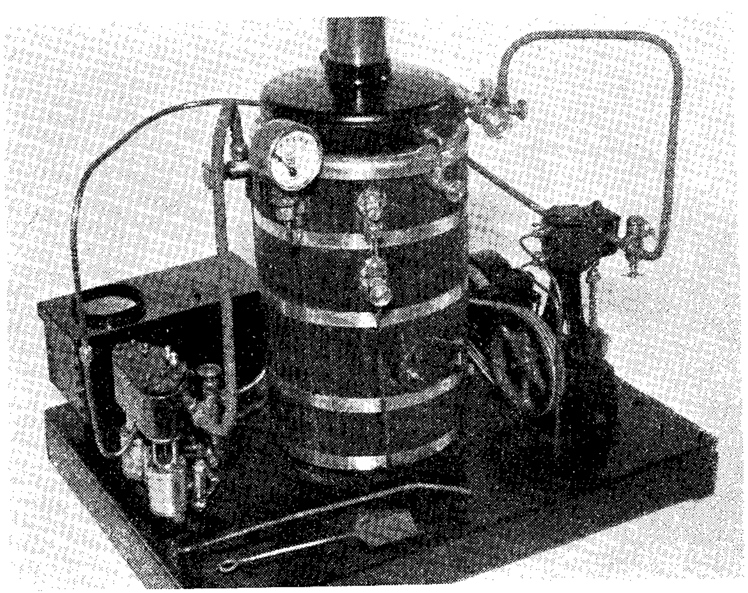
THIS year's Huddersfield Exhibition was undoubtedly a great success, not only from the quantity of the work displayed, but also from the quality, which, to your correspondent at least, is the more important.

The first thing that struck me on entering the hall was the sound of a fairground organ, and sure enough surrounded by the usual large crowd, there was H. Slack's lovely set of gallopers. Even when one has seen them many times before, they are as fascinating as ever !

There were other old friends, too: R. Wood of Leeds and his beautiful table engine, and L. R. Raper of Wakefield with his wellnigh perfect tank engine—I say wellnigh, because I suppose there *must* be a blemish somewhere, though I've not found it yet ! Both these models have won championship cups at " M.E." Exhibitions, and have been described in past articles.

A " Fixed Agricultural Engine "

Another old friend, sprightly as ever, was H. Booth of Bingley, but his model was a new one—a twin-cylinder stationary steam-engine of $1\frac{3}{16}$-in. bore by $1\frac{7}{8}$-in. stroke. The prototype of this was built in 1876 by Barrett, Exall, and Andrews, of Reading, for farmers and others. This was an attractive engine, well built and well finished (as is to be expected from Mr. Booth), with overhead valves worked by rocking-levers, and complete with governor and water-pump. Incidentally, it was built in six weeks and two days, which is not bad going for a man of sixty-eight ! And it is his fifty-fourth model !



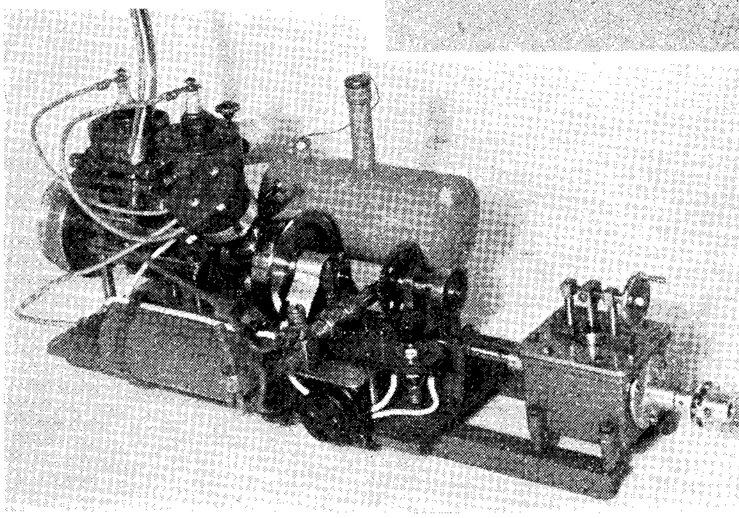
A complete steam plant exhibited by E. A. Preston, with vertical boiler, engine, dynamo, and steam-pump

Another name well known to readers is that of F. D. Woodall, of Shipley, who has specialised in model steam-engines, usually built to the scale of 1 in. to 5 ft. His prototypes are always of interest, being invariably out of the rut, and his models are always well detailed and well finished. At Huddersfield he exhibited a model of a "standing" engine, or winding-engine for inclined railways, based on examples he has visited. (An actual prototype is now in the York Museum.) The engine is set in a house, with the front wall broken away so that it may be seen, and the boiler-house at the front. At the back of the engine-house is the staging supporting the winding-drum.

The engine-cylinder is set in the floor, driving up to an overhead crank, the bearings of which are mounted on an entablature supported by two columns. These are tenoned into the entablature and cottered. The parallel motion which constrains the cross-head consists of two pairs of equal levers, the inner ends of which are connected by links, and the outer ends are held on fixed pivots. The crosshead being attached to the centre of the links is thus forced to keep to the straight and narrow path. Reversing is effected

by slip-eccentric, with provision for hand working the valve. The flywheel is staked on to the crankshaft, whose outer end carries a 14-tooth shrouded pinion driving the 96-tooth spur-wheel on the winding-drum. The other end of the drum has a brake which is operated by a lever on the floor of the house.

The boiler is made to look like the real thing, with coal around the stoke-hole, though it is actually



A two-cylinder petrol installation with forward and reverse gearbox, by Dr. J. Fletcher

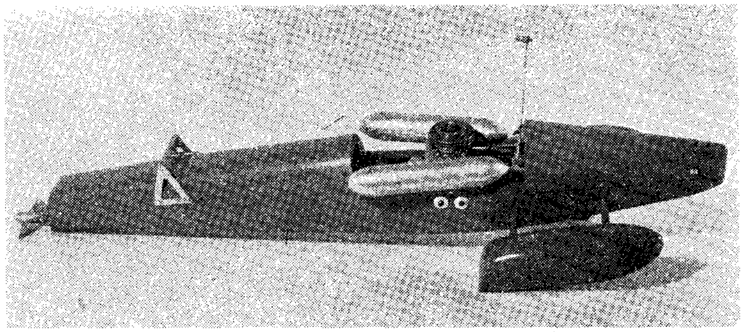
fired by spirits. This model, too, created lots of interest, especially when Frank had her in steam for several hours.

More Steam Engines

Another steam-engine was the compound mill-engine built by R. Eloy of Wakefield. I gave a brief description of this in THE MODEL ENGINEER, dated April 23rd, 1953, and readers may care to turn up the photograph then published. The model is now completed; its chief and most interesting feature is, of course, the triangular connecting-rod enabling both cylinders to drive the single crank.

Very full detail includes a centrifugal governor on the crankshaft, a beautiful little stop-valve, mahogany lagging with brass bands, pressure release-valves on the cylinders, and a spoked flywheel which is grooved for rope-drive. The model is quite small, its overall height from base-board being only $7\frac{13}{16}$ in.

A complete steam-plant was exhibited—and run—by E. A. Preston

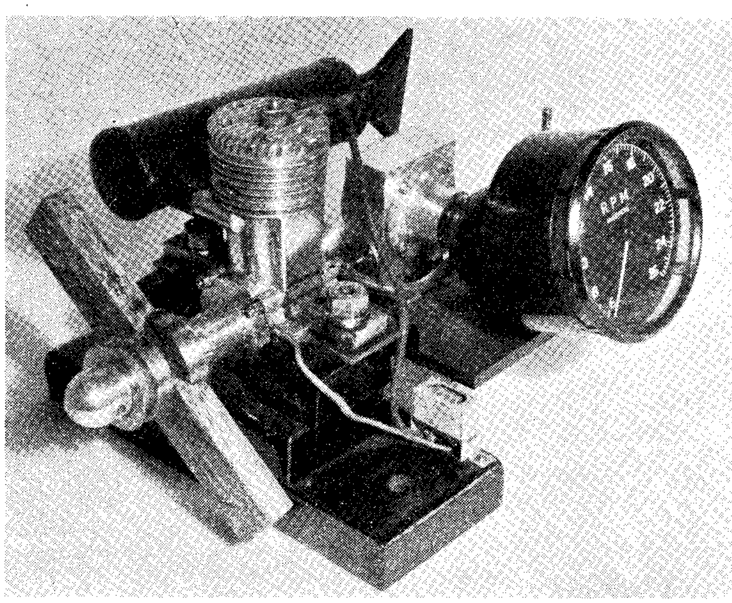


Hydroplane based on the "Sparky" design, built and engined by J. D. Tetley of Huddersfield

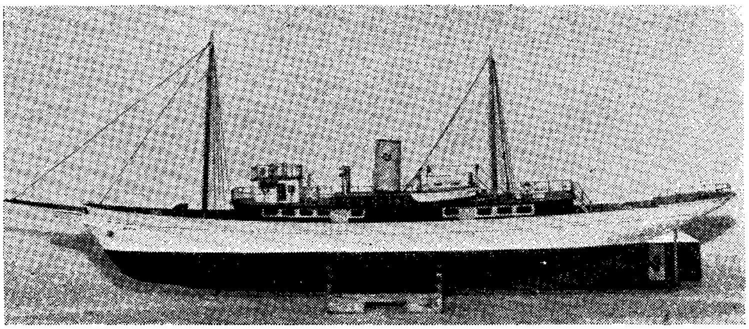
of Huddersfield, consisting of "L.B.S.C.'s" vertical boiler, a Stuart Ten engine, a dynamo converted from the motor of a klaxon horn, and an Austen-Walton donkey-pump, with an emergency hand-pump in the water-tank. Finish was good, although obviously the model had seen quite a lot of running.

Internal Combustion Engines

Another Northerner who has gained high honours at the London exhibitions is Dr. J. Fletcher of Colne. We now had the pleasure of seeing his seven-cylinder radial aero-engine, which is a supercharged two-stroke, and the power-plant for his model pilot-cutter. This plant is very complete, with an excellent finish. There are two



A 10-.cc. glow-plug engine by T. Brooks of Rochdale, mounted in a test-bed



This excellent steam-yacht model was built by Brian Littlewood, now aged sixteen, of Huddersfield

separate water-cooled cylinders, and the water-pump is driven by reduction-gear from a countershaft, which itself is driven at a reduced speed from the crankshaft. The countershaft is coupled to a gearbox, which has forward, neutral, and reverse with handwheel control.

T. Brooks of Rochdale had a very neat 10-c.c. glow-plug engine mounted in a test rig, complete with revolution counter and silencer. Maximum revs. were stated to be 22,500, so one would imagine the latter to be really necessary ! This excellently finished engine had a die-cast cylinder, crankcase, and piston.

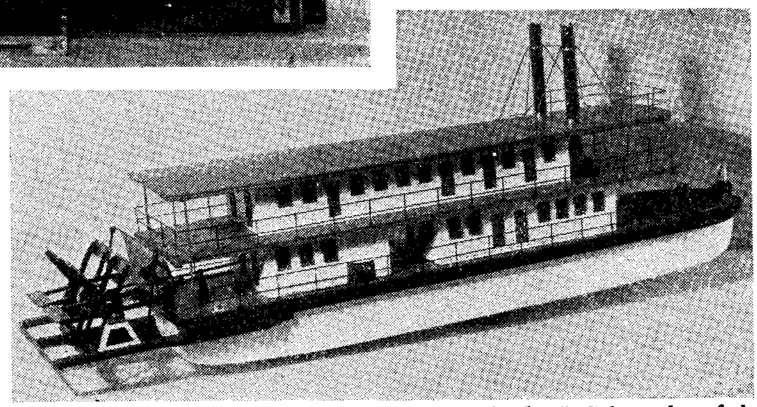
Another efficient-looking 10-c.c. glow-plug engine was installed in a hydroplane built by J. D. Tetley of Huddersfield. The 360-deg. transfer and exhaust ports were incorporated in an aluminium block surrounding the cast-iron (or perhaps meehanite) cylinder, and a rotary-disc inlet-valve was fitted.

The hull was based on G. Lines's " Sparky " design, with a plywood hull riding on two sponsons. The boat was awarded First Prize in its class.

Marine Models

On the marine side, which was very well represented, I was pleased to see that Brian Littlewood, whose steam-yacht was mentioned in my report of the Sheffield Exhibition, has taken time to improve the general finish on his boat. The result is a great improvement, and Brian's yacht was well worthy of the First Prize in the Junior section.

A rather unusual prototype had been chosen by J. Sykes of Huddersfield—a Mississippi stern-wheeler. The model was unfinished, but already possessed something of the atmosphere of the big boats. However, it was rather spoiled by the position of the engines, which were inside the hull, driving the paddle-wheel through a central shaft and bevel gears. The boat's appearance would be vastly improved, especially in motion, by the overhung cranks on the ends of the paddle-shaft, with the iron-bound wooden connecting-rods of the prototype !



An unfinished model of a Mississippi stern-wheeler by J. Sykes, also of the Huddersfield club

A well-designed and self-contained power-plant for a steamer was exhibited by J. M. Crowther, of Huddersfield. The whole was mounted on a base of brass angle, the engine having a steel-plate base bolted to this. The oscillating cylinder was fabricated, and carried on four columns.

The boiler-shell was of oval section, with fourteen vertical flue-tubes, and was spirit-fired. Other details included a tin-plate boiler casing with brass funnel, a displacement lubricator, and an oil-trap in the exhaust system.

(To be continued)

TALKING ABOUT STEAM

(Continued from page 642)

The " Wallis " Expansion Gear

Coming to more modern times, we have already mentioned the expansion gear fitted to some Wallis and Steevens traction-engines. In the previous article (October 8th issue), I could deal only briefly with this, so here is more information about it. The diagram is reproduced by courtesy of Messrs. Wallis and Steevens Ltd., of Basingstoke, from one of their catalogues, and the photographs are my own, taken from Mr. Romane's engine *Eileen* at the " M.E." Exhibition.

It will be seen that, in effect, the outer valve consists of two blocks, and as it slides on the inner valve, these will cover or uncover the outer ports of the latter. As their travel is increased or decreased by the lowering or raising of the die lifting-rod, so the cut-off is increased or decreased.

The position of the rod is controlled by the short vertical lever on the footplate, which can be locked in any position. The regulator is left fully open, normally, when running, and the engine controlled by the expansion-lever according to the work required of it.

When driving machinery, the expansion die lifting-rod is uncoupled from the bell-crank connected to the hand lever, turned round, and coupled to the arm connected to the governor. In the diagram, this arm cannot be seen in the elevation, but is visible in the photographs—actually, as seen in Photograph No. 2, there are twin arms passing on each side of the governor spindle. So the governor takes over control of the expansion-valve, and no throttling or wire-drawing of the pressure takes place.